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AN ANALYSIS OF THE RELATIONSHIP BETWEEN THE FINANCIAL CONDITION OF MAJOR DEFENSE CONTRACTORS AND DOD SPENDING

by

Michael Joseph Vormbrocke

December, 1991

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O. Douglas Moses

22b TELEPHONE *(Include Area code)*
(408) 646-3218

22c OFFICE SYMBOL
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An Analysis of the Relationship Between the Financial Condition of Major Defense Contractors and DoD Spending

by

Michael Joseph Vormbrocke
Lieutenant, United States Navy
B.S.,United States Naval Academy, 1983

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ABSTRACT

The purpose of this thesis is to examine the relationship between the financial condition of defense contractors and the amount of Department of Defense spending from 1975 to 1990. The sample for this study consists of eighteen major defense contractors. The relationships are examined at two levels. The first level is that of the financial condition of the defense industry in the aggregate. The second level is that of the individual defense contractors. The major findings of this study are that: 1) the aggregate industry of defense contractors has experienced a declining financial condition from 1975 to 1990; 2) a positive relationship seems to exist between the financial condition of the defense industry and the amount of defense spending; 3) no consistent relationship between the financial condition of the individual defense contractors and the amount of defense spending is apparent.

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I. INTRODUCTION

The size of the National Defense Budget has provided much heated debate throughout the years. Those in favor of increased defense spending engage those opposed at all levels from the electorate to the legislators. "How much should our nation spend on defense?" is a question which has no definitive right or wrong answer. Only subjective answers persist.

Defense spending has had a tremendous impact on the economy in several regions of the United States and on several industries. As defense spending has risen or fallen, so to has the "prosperity" of those regions and industries directly related to defense. (Craig, 1988 and Gansler, 1980)

Those opposed to huge defense budgets focus on the social and educational problems and the decaying infrastructure that could be addressed by less defense spending. Even President Dwight D. Eisenhower warned of too strong a military-industrial complex in the 1950's. He believed that the resources of the nation could be more efficiently and productively used in the market economy (Enthoven and Smith, 1971, pp. 8-9).

Those in favor of increased defense spending argue in the non-quantifiable terms of ensuring national security and expound on the many civilian uses of defense-related technologies. It is also emphasized that the complexity of modern weaponry requires more specialized production equipment and longer production times than weaponry used in the past.

The last twenty years are a graphic example of the cyclic nature of defense spending. Defense spending peaked during the Vietnam War and fell quickly afterwards and throughout the Ford administration. Small increases to defense spending were made during the Carter administration. A steep military buildup lead to the highest levels of defense spending in United States history during the Reagan administration. Since 1985, the defense budget has steadily declined.

The fall of the Berlin Wall, the new openness in Eastern Europe, and the breakup of the Soviet Union have lead many advocates to demand a huge peace dividend. But the impact of defense cuts goes beyond just the United States Armed Forces. The cuts will also affect local economies, the United States military industrial base, and the ability of many military contractors to continue as viable entities. Defense spending reductions have wide spread impacts and strategic implications.

President Bush has stated that one of the major strategies that the United States has embraced in the New World Order is the ability to reconstitute its forces if the need should arise (Bush, 1990, p. 5 and The White House, 1991, pp. 29-31). An important factor in force reconstitution is the ability of the United States industrial base to meet military surge requirements. This ability will surely be limited if major military contractors are financially weakened by cuts in defense spending.

A. OBJECTIVE

The research question examined is: What impact does the amount of Department of Defense spending have on the financial condition of major military prime contractors?

This study did not attempt to fully answer the broad questions of future reconstitution capabilities and overall industrial base impacts by the present Department of Defense (DoD) spending reduction projection, but rather it sheds some light on a small portion of these major questions. The reported financial data of eighteen defense contractors was analyzed in order to relate the financial health of these companies to the changes that have occurred in defense spending levels over the past sixteen years. The selected contractors are a representative sample of the largest defense contractors.

The period from 1975 to 1990 was chosen for the fluctuations of defense spending and economic conditions during the period and for the availability of data. It is not considered that the past sixteen years are representative of future eras or previous eras. The intent of this study is to shed light on these sixteen years as a basis for future study of what could be expected to occur.

In analyzing the research question, the approach used was to identify top DoD contractors and determine their "financial health" based upon an accepted model. The financial health of the contractors was then related to DoD spending by using linear regression statistical techniques.

In the data collection process, there were limits on source materials and periodic changes in accounting conventions. Generally, the accounting data was standardized to conform to currently valid financial statement definitions.

B. FINDINGS

The findings of this study show that a positive relationship probably exists between the amount of defense spending and the financial health of the aggregate defense contractors used to represent a portion of the defense industry in this study. However at the individual contractor level, the relationship between defense spending and the financial condition for individual contractors is not clear. Much of the haziness of the relationships can be attributed to how the management of each contractor responds to the changing environment vice just the amount of DoD spending.

C. METHODOLOGY

This study was conducted in seven major steps: 1) literature review, 2) statement of research hypotheses, 3) planning the sample, 4) conceptualizing the constructs and measures, 5) collecting the data, 6) structuring the relationships to be tested, and 7) analyzing the data with statistical techniques.

The first step was to conduct a literature review of defense spending and its impact on the financial condition of defense contractors. This review provided an overall qualitative assessment of how defense spending is measured, its fluctuations over the past sixteen years, and previous related studies on this topic. Further literature reviews were conducted on financial ratio analysis and models for determining the financial condition of companies.

The second step was to state the research hypothesis. This hypothesis and further questions flowed from the literature review. Further hypotheses were developed stating the relationships expected between various DoD spending measures, contractor financial condition measures, and control variables.

During the third step, the planning of the sample was performed. This entailed defining the major defense contractors in order to select a representative sample. A balance was sought to ensure that the sample was large enough to be statistically significant yet small enough to be analyzed within the available time constraints imposed on this study. Eighteen defense contractors were selected for the sample.

The fourth step entailed conceptualizing the constructs and developing measures designed to reflect the constructs. Three areas were studied to fully develop the constructs and measures in this step. First, the dependant variables (financial condition of defense contractors) were conceptualized and measured. Textbooks, ratio studies, and previous studies on defense contractors were reviewed to identify the dimensions of the financial condition for defense contractors best suited for this study.

Second, the independent variable (DoD spending) was conceptualized and measured. Relevant dimensions of DoD spending were identified to select the most representative measure that impacts DoD contractors. Defense outlays, total defense prime contract awards, and the sum of procurement and research and development outlays were reviewed for this measure. Along with each of these dimensions of DoD spending, the yearly change of each variable was determined and included as a relevant measure of the impact of DoD spending on the financial health of the contractors. Some of the other independent measures identified included DoD outlays as a percentage of GNP, DoD spending as a percentage of total federal spending, and total prime contract awards as a percentage of DoD spending.

Finally, control variables were conceptualized and measured. These were used to take into consideration other factors that can reasonably be expected to impact the financial condition of defense contractors. Control variables that were assessed include GNP, industry capacity utilization, and the percentage of DoD business for each contractor.

The fifth step involved collecting the required data for this study. General data on the defense contractors were available through standard references at the Knox Library and annual financial reports. Detailed information on DoD spending was also available at Knox Library in several government published reports. Data to measure the control variables were available through published government reports.

In the sixth step, the analysis of the relationships between the independent and dependant variables began by structuring the relationships to be tested. The tests were conducted on two levels. First, relationships between DoD spending variables and variables reflecting the aggregate defense contractor financial condition were tested. Second, relationships between DoD spending and the financial condition of individual firms were examined.

The seventh step involved using statistical techniques for the following three purposes:

1. To provide descriptive information on the dependant, independent, and control variables individually. This was done using means, standard deviations, and ranges.

2. To provide an initial picture of the interrelationships between the chosen variables using pairwise correlation. Outcomes of this analysis were: 1) some of the variables were highly related and thus measured the same constructs; 2) indications of strong relationships between the dependant and independent variables were revealed.

3. To provide a formal model of relationships between the dependant and independent variables while considering the control variables. Regression was used for this model.

D. CHAPTER OUTLINE

This thesis is presented in five chapters. Chapter I provides the introduction for this study by stating the research objectives, findings, and methodology. Chapter II lays out a background on the national and defense budget to provide an historical perspective on past fluctuations in defense spending. It also provides the basis for selecting the independent measures of defense spending that were later related to the financial condition of the defense contractors.

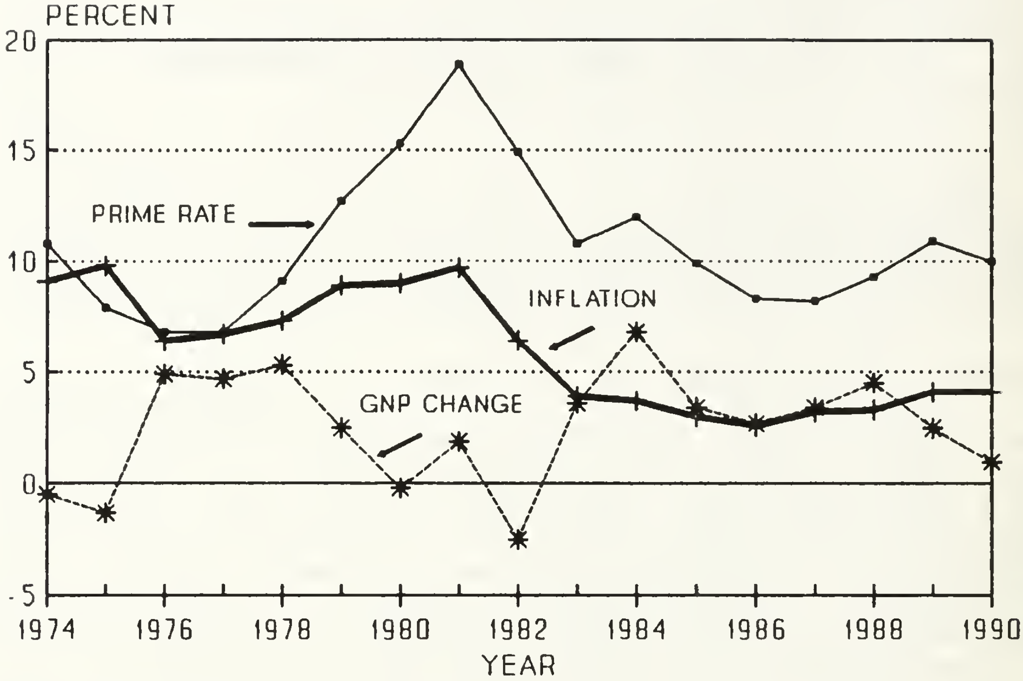
The next two chapters discuss the methodology and analysis used for this study. Chapter III details the seven step procedure undertaken to conduct this research. The problems and limitations on this study are also described in this chapter. Chapter IV provides the analysis of the data obtained and developed throughout this study.

Chapter V summarizes the major findings and conclusions that this study has reached.

II. HISTORICAL BUDGET BACKGROUND

The period from 1975 to 1990 experienced economic shifts which impacted all sectors of American industry. In the late 1970's, high inflation and interest rate swings affected the economy. This period was followed be a period of recession from 1980 to 1983. The recession aided in easing interest rates and inflation. From 1984 to 1990, the United States underwent its longest peacetime economic expansion as the gross national product (GNP) continued to grow throughout the period. Not until the second half of 1990 did another recession begin. Interest rates dropped from their early 1980 highs but maintained a level higher than historical averages. Figure 1 shows the changes of the prime rate, GNP, and inflation (GNP deflator) from 1974 to 1990.

Just as the rest of American industry had to face these economic fluctuations, so too did the defense industry. Increased attention was directed at studying the impact of these economic conditions on the ability of the defense industry to meet defense needs. Congressional hearings, Department of Defense memorandums, and various studies were conducted to assess and address the challenges these conditions placed upon the defense industry. (DFAIR, 1985, p. I-2)



Inflation is measured by GNP deflator.
Source: Economic Indicators

Figure 1. Prime Rate, GNP Change, and Inflation

A. NATIONAL AND DEFENSE BUDGETS

A basic understanding of the national and defense budgets over the period is needed to place the research question in context. This background serves two functions in relation to the rest of this study. First, the fluctuations of the defense budgets over the period are noted. Second, this background provides the basis for determining which measures best capture how these defense budget fluctuations impact the financial condition of the defense contractors.

In discussing the national budget, the distinction is made between budget authority and budget outlays. Budget authority is that amount which Congress annually authorizes and appropriates to spend. Budget outlays is the annual amount that is actually expended. Budget authority and outlays differ due to reprogramming, sequestration, and impoundment actions.[1]

The salient point here is that outlays reflect the actual amount expended in a twelve month period (fiscal year). This actual expenditure is what impacts the defense contractors. Therefore "outlays reflect the total burden of national defense as a component of the total United States federal defense budget; they are an appropriate measure of national security spending in an economic sense." (Lewis, 1990, p. 17)

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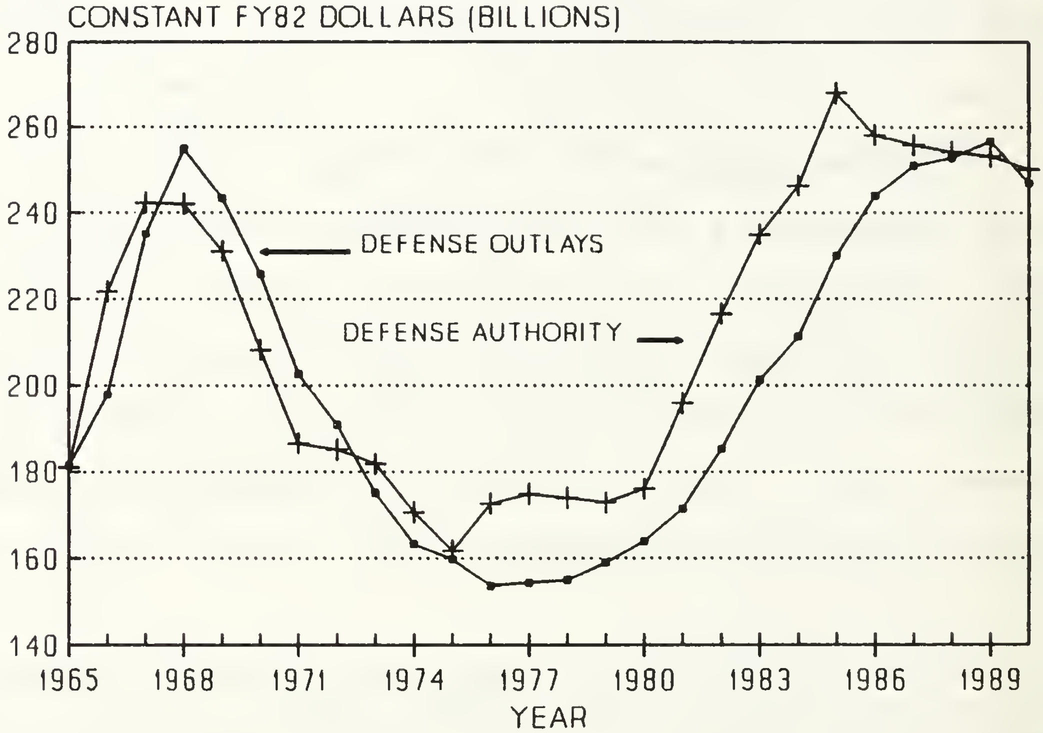
[1] Budget authority is sometimes confused with total obligational authority (TOA). Budget authority refers to that amount which Congress allows DoD to spend regardless of the year the funds become outlays. Budget authority must be converted to outlays within a certain number of years, depending on the account, or they will expire. Total obligational authority is a DoD specific term which includes all revenues from Congress, foreign sales, and the sale of assets, etc. Many studies use TOA as a measure of defense spending ability. Budget authority and TOA are normally very similar since the vast majority of DoD spending is from Congressional appropriations.

One further distinction is between the terms DoD Budget Authority and National Defense Authority. National Defense Authority includes defense spending by other government agencies such as the Department of Energy (DOE), which is the largest non-DoD spender on national defense. In current-year dollars, DOE's contribution to national defense has risen from 1.5 to 9.0 billion dollars between 1975 and 1990. This paper will consider defense spending to include all defense-related spending by all government agencies unless otherwise stated.

Figure 2 is a graph of DoD Budget Authority and DoD Budget Outlays from 1965 to 1990 and shows the fluctuations in defense spending. Budget authority is normally a leading indicator of outlays.



Source: OMB

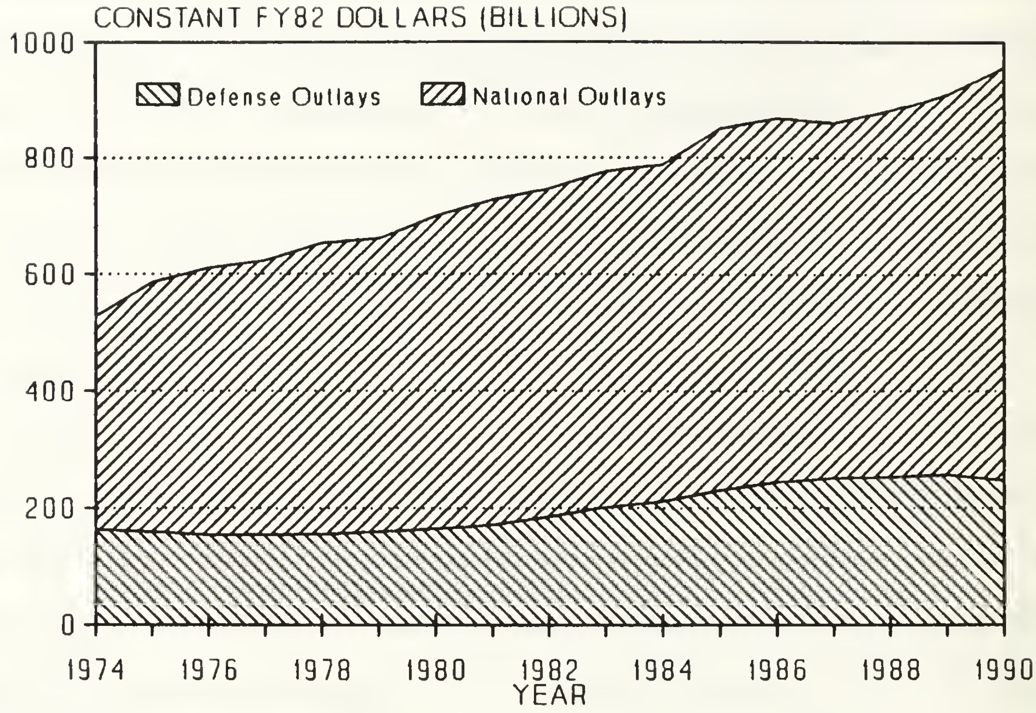
Figure 2. Defense Outlays and Defense Authority

The 1975 to 1980 period was preceded by a steep decline of United States military spending after defense outlays peaked in 1968 during the Vietnam War. Not only did defense spending decline from 1969 to 1975, but manpower levels were reduced; and quality, morale, and readiness were greatly impaired (Lewis, 1990, p. 25).

From 1975 to 1980, a limited expansion in the military occurred due to the sharp declines from the Vietnam era and due to the improvements made by the Soviet military. Also contributing to this slight military spending increase were world events highlighted by the fall of the Shah of Iran and the Soviet invasion of Afghanistan.

During the first Reagan administration, an unprecedented peacetime military expansion was conducted. In constant 1982 dollars though, military spending did not exceeded the Vietnam War high in 1968 of $254.8 million until 1989 when it reached $256.6 million. Defense budget authority peaked in 1985 which signalled the coming decline in defense spending. Defense outlays peaked in 1989. The events in Eastern Europe and the Soviet Union from 1989 to 1991 continue to put pressure on policy makers to further decrease the military budget.

Studies on the federal budget from the end of World War II to the present show that total federal budget outlays grew at nearly $21 billion a year in constant 1988 dollars. (This is equivalent to $18.3 billion 1982 dollars.) Defense spending, with its peaks and valleys, oscillates around $233 billion per year in 1988 dollars ($203 billion in 1982 dollars). On the other hand, non-defense spending has continued to grow since the early 1960's due to entitlement programs, social program expansion, and debt financing. (Lewis, 1990, pp. 40-41) Figure 3 demonstrates these findings from 1974 to 1990.

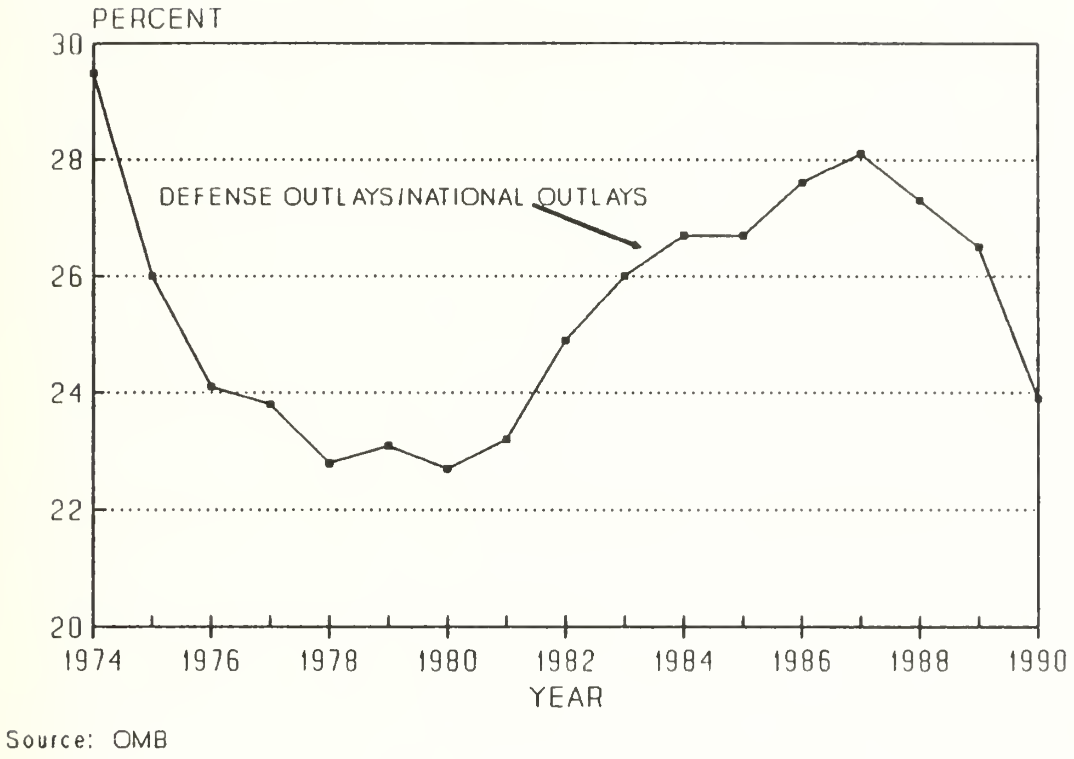


Source: OMB

Figure 3. National and Defense Outlays

Figure 4 shows how defense spending as a percentage of the total federal budget outlays has varied over the past sixteen years. The high over the period was in 1974 at 29.5 percent. The low occurred in 1980 at 22.7 percent. The present trend appears to be headed lower from its 1990 level of 23.9 percent.

Figure 5 shows how the federal budget outlays and total defense outlays as a percentage of GNP have varied from 1974 to 1990. The total federal budget outlays as a percentage of GNP have varied between 19 percent in 1974 to a high of 23.9 percent in 1983. Total defense outlays as a percentage of GNP

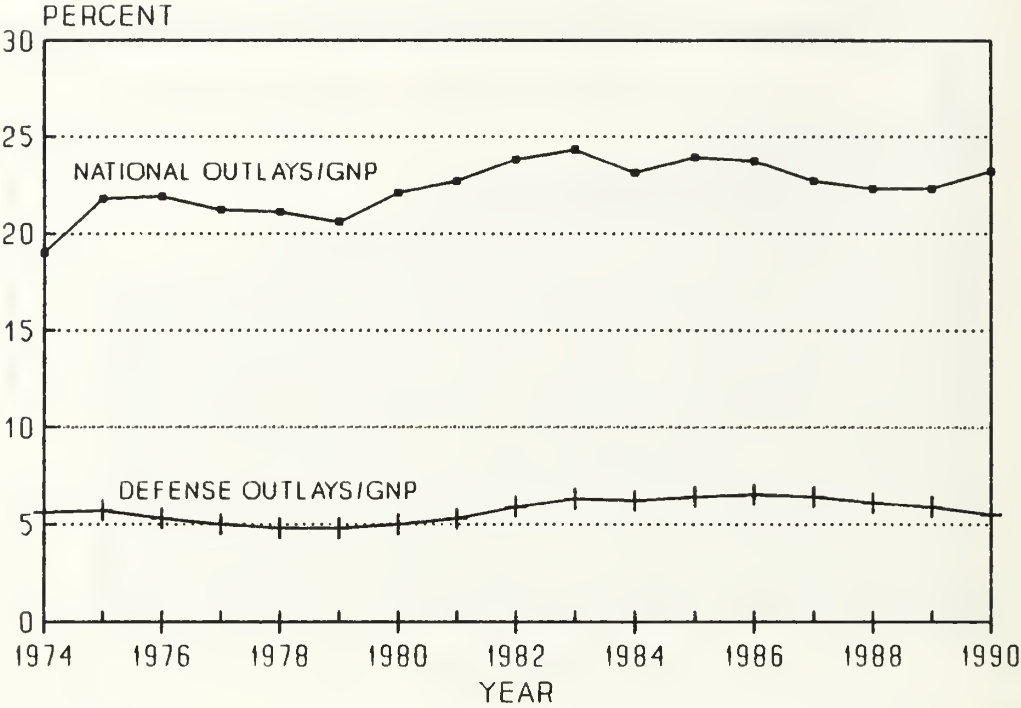


Source: OMB

Figure 4. Defense Outlays/National Outlays

have ranged from a low of 4.8 percent in 1979 to a high of 6.5 percent in 1986. Projections from the Secretary of Defense are that the percentage of defense spending to GNP will reach 4.0 percent by 1995, a fifty year low (Hearings, 1990). The average defense to GNP ratio from 1947 to 1988 was 7.7 percent with an average rate of change of -0.2 percent (Lewis, 1990, p. 45).

The Constitution states that the Congress has the responsibility "to raise and support Armies" and "to provide and maintain a Navy". While the President is the Commander-in-Chief of the armed forces, it is the Congress who



Source: OMB

Figure 5. National Outlays/GNP and Defense Outlays/GNP

determines the size and make-up of those forces by holding the "power of the purse". It is this control of resources for the armed forces that has provided Congress the oversight responsibility and influence it possesses. This oversight has increased in recent years due to pork barrel politics, lack of trust between the Congress and DoD due to "overpricing scandals", and the amount of the discretionary federal budget in the DoD budget.[2]

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[2] The discretionary portion of the federal budget is money that Congress can vary in level without changing existing entitlements or benefits, many of which are indexed to inflation.

> The roots of micromanagement of DoD activities can also be traced to a federal spending disparity. By 1985, although the defense budget represented only about 26 percent of total federal outlays, it accounted for nearly 65 percent of total discretionary spending. (Fox, 1988, p. 83)

The Defense budget structure is typically broken down into five major titles or appropriation accounts which fall under two types. Expense-type appropriations are (1) Operations and Maintenance (O&M) and (2) Military Personnel. Investment-type appropriations are (1) Procurement, (2) Research, Development, Test, and Evaluation (RDT&E), and (3) Miscellaneous to include Military Construction, Family Housing, and other accounts for management trust funds, revolving funds, foreign currency translations, etc.

Historically, procurement has been the largest individual title of the DoD budget since it is based on major acquisition programs for tanks, aircraft, ships, and missiles. However, in the 1970's, O&M was larger than procurement (Lewis, 1990, p. 72). Procurement peaked in 1987 and has since tended to decline due to cutbacks in defense budget authority and outlays. Figure 6 shows the defense budget broken into its major appropriation categories.

Figure 7 shows the same data as in Figure 6 except that it relates all the accounts as a percentage of total DoD spending. The investment accounts were below historical levels in the 1970's, increased in the 1980's, and never exceeded 50 percent of DoD spending.

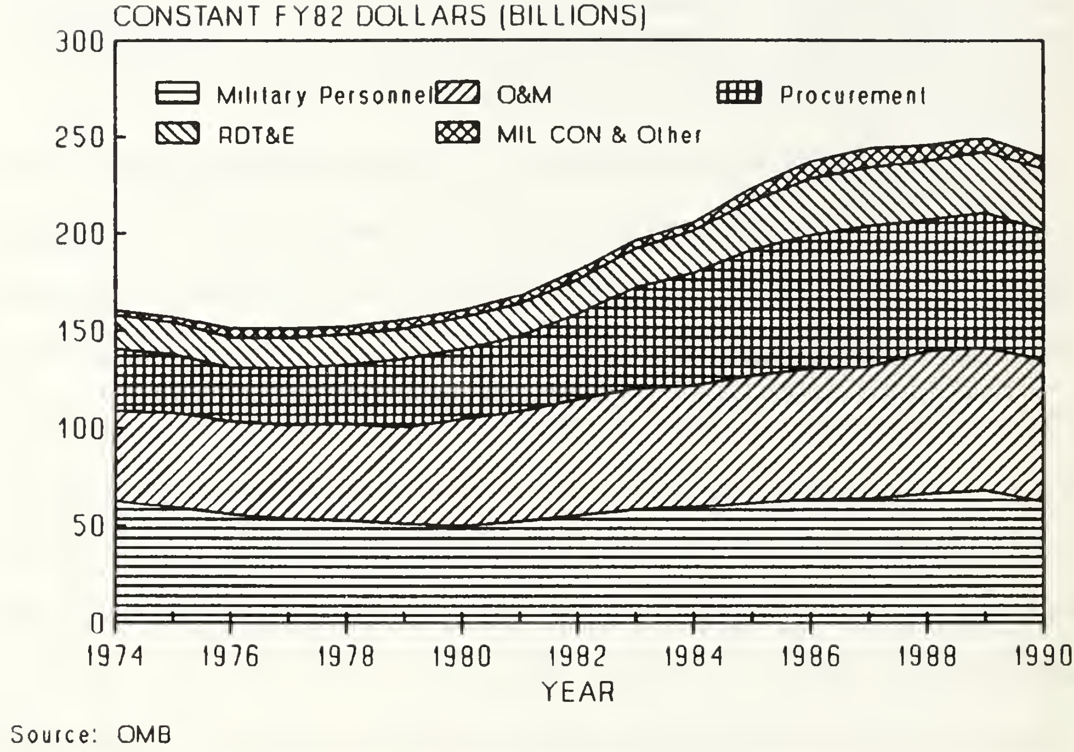
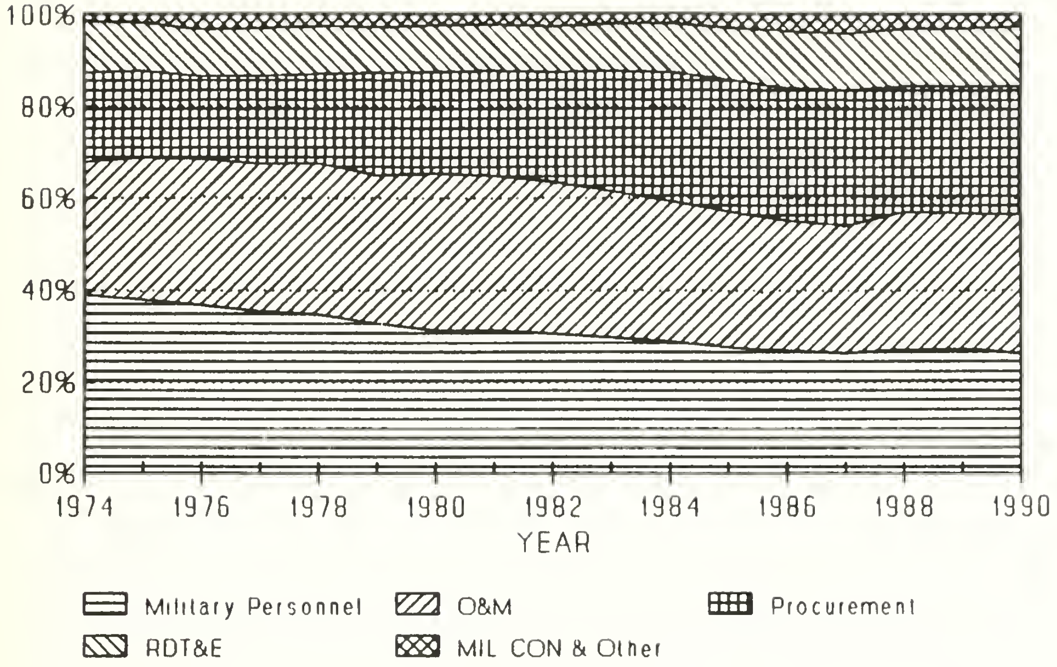


Figure 6. Defense Budget by Subfunction

The study by Kevin Lewis (1990) on the defense budget points out that when the defense budget has changed, the procurement appropriations are the most volatile of all the defense accounts. During increases and decreases in defense spending, procurement has respectively increased and decreased proportionately more than has the other accounts. Research and development has remained fairly consistent at around ten percent of the defense budget.

> Procurement is, in some sense, the "slack variable" of the DoD. Regardless of the direction of budget movement, procurement authority is the most affected component within the DoD budget by top-line change. (Lewis, 1990, p. 81)



Source: OMB

Figure 7. Defense Budget by Subfunction (Percent)

The Procurement Title is considered to be the "slack variable" since it can be expanded rapidly to procure additional quantities of end items. The Procurement Title line items are usually funding-limited and not production-limited. Therefore, program requirements are spread over a period of several years to lessen impact for funds and not to restrict the industrial base. When an influx of increased budget authority is inserted into the Procurement Title, individual buy quantities are increased to deliver the needed items earlier. Conversely, when a significant decrease in defense budget authority occurs, the Procurement Title can be reduced rapidly.

The operations of the forces can be changed; but to have the same effect that changes in procurement outlays have, a large amount of operational exercises would have to be affected which would then impact on military readiness. Military personnel levels also can not be altered quickly enough to affect the military personnel account to the same extent that alterations in procurement outlays can impact overall defense spending.

The implication this large variability in the procurement account has on this study is that whereas defense budget outlays have varied over time, the procurement accounts within the defense outlays have varied to an even greater extent. The larger variability in the procurement account is more directly felt by major DoD contractors than is overall variability of the defense outlays in total.

B. DOD PRIME CONTRACTORS

Department of Defense prime contractors include parent companies and their subsidiaries which provide worldwide contract actions of supply, service, and construction to DoD.

The amount of DoD contracts awarded to prime contractors is dependent on the annual amount appropriated by the Congress. The majority of dollars in DoD prime contracts awarded is from the procurement and RDT&E appropriations for major weapon system acquisition. However, a substantial amount of major contract dollars is also appropriated in O&M for service contracts for such items as telephone service, fuel oil, base support, and other operational type requirements.

Figure 8 shows the amount of prime contracts awarded from 1974 to 1990. Comparing the cycles in Figures 1 and 8 shows that defense cycles have not necessarily coincided with the rest of the economic cycles. DoD prime contract awards steadily grew from $73 billion in 1975 to $137.1 billion in 1985, an 88 percent increase. The largest increases occurred during the first two years of the Reagan administration. From 1985 to 1990, the DoD prime contract awards began to decline in current dollars. When constant dollars are considered, the decline is even sharper. Therefore, the defense industry must now compete for even less dollars that are available for defense prime contracts yet meet the cutting-edge of technology demands of DoD.

The source of information used for determining the amount of annual DoD prime contract awards and the companies that received them was *100 Companies Receiving the Largest Dollar of Prime Contract Awards*, a DoD Directorate for Information, Operations, and Reports (DIOR) annual publication. Some noted items from this source include:

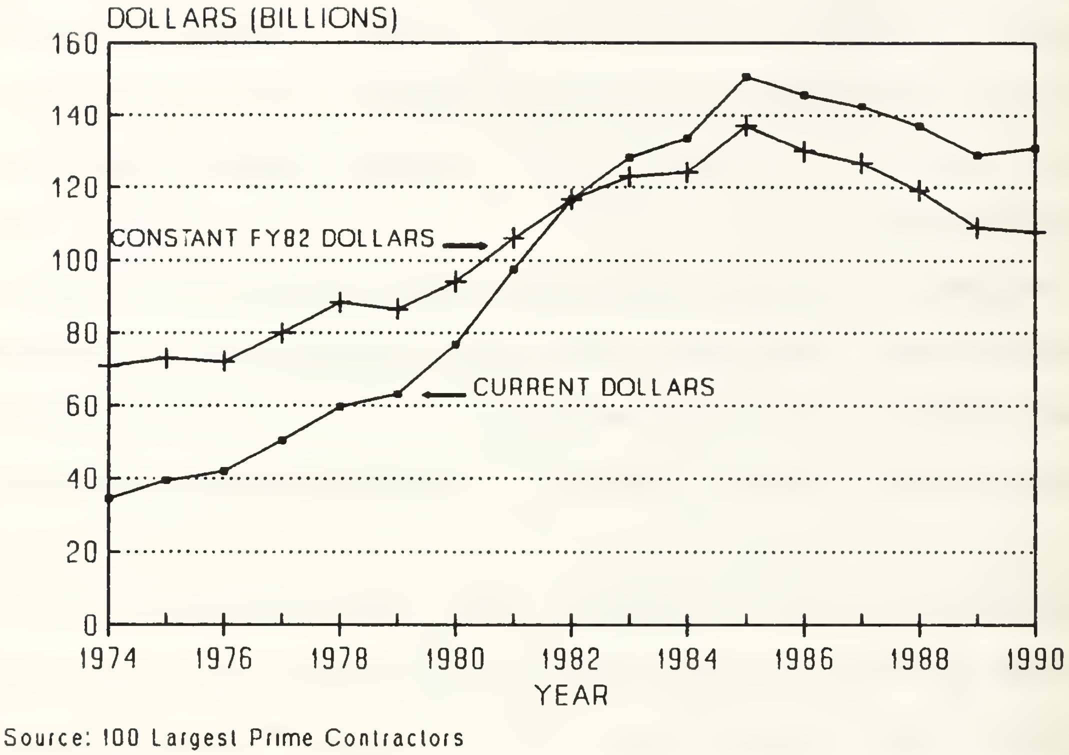


Figure 8. DOD Prime Contract Awards

1. From 1975 to 1982, the prime contract awards were based on contracts greater than $10,000. Since 1983, the publication has been based on awards greater than $25,000.

2. The prime contract awards listing does include research and development contracts but does not include contracts made by other U.S. Government agencies and financed with DoD funds.

3. The prime contract awards as a percentage of budget authority ranged from 41.5 percent to 54.1 percent.

4. The top 100 companies listed each year received between 65.8 percent and 70.1 percent of the total contracts awarded.

5. The eighteen companies selected in this study cumulatively received between 33.2 percent and 45.0 percent of the total DoD contracts awarded with a cumulative total from 1975 to 1990 of 41.0 percent.

C. SUMMARY

This chapter has highlighted the fluctuations in government defense spending over the past sixteen years. It also has pointed out that total defense outlays are not necessarily the best indicator of the impact that defense spending has on defense contractors. A better indicator is the amount of annual prime contracts awarded, although there are limitations in this measure that will be discussed in Chapter III. Finally, of the total amount of defense prime contract awards, a select few contractors have received a large percentage of the contracts. This fact provides the opportunity to study and analyze this select group of contractors to evaluate findings which would be applicable to the entire defense industry.

III. METHODOLOGY

This chapter describes the process used to study the research question. The process entailed seven steps which include: 1) a literature review, 2) statement of research hypothesis, 3) planning the sample, 4) conceptualizing the constructs and measures, 5) collecting the data, 6) structuring the relationships to be tested, and 7) analyzing the data with statistical techniques.

A. LITERATURE REVIEW

The literature review was conducted in four areas: (1) studies on the national and defense budgets, which were summarized in Chapter II, to determine the best measures to use for the independent variable of defense spending, (2) previous studies on the financial condition of defense contractors to assess the depth and the methods used for analysis in these earlier studies, (3) financial ratio studies to assist in determining which financial ratios to use in evaluating the financial condition of the defense contractors, and (4) models of the financial condition of firms, including bankruptcy-related models, to provide a single summary measure of financial health.

1. Studies on Defense Contractors

Although much has been written about the defense industry in the popular press, there are few in-depth reports or analyses that have been conducted on the financial condition of DoD contractors. Numerous analyses have been performed on the closely related themes of defense contractor profitability or the prediction of defense contractor financial distress.

This section briefly describes six studies on defense contractors that were reviewed to provide an impression of related previous studies and their conclusions. These studies shed some light on what independent and control variables should be considered for this analysis.

In 1983, the Deputy Secretary of Defense (Acquisition Management) chartered the Defense Financial And Investment Review (DFAIR). Its objectives were to study and make recommendations concerning contract pricing, financing, and profit policies to determine if public funds were being spent efficiently. The study was also structured to determine the status of the defense industrial base. The period covered in the DFAIR was 1975 to 1983. In effect, this review was an extension of an earlier study called "Profit '76" which had similar objectives in reviewing the 1970 to 1974 period. The DFAIR concluded that the interests of the taxpayer were being protected, and the defense industry was achieving an equitable return for its defense business (DFAIR, 1985, p. E-1).

A General Accounting Office (GAO) report on the DFAIR study questioned the methodology used in the DoD study and concluded that defense industry profits were actually greater than those in the commercial sector (GAO, 1986, p. 2).

A Naval Postgraduate School thesis by John Morse and Kenyon Kramer in 1985 titled *DoD Contractor Profitability 1980-1984* also concluded that during the period studied, DoD prime contractors were more profitable and exposed to less risk than like-size commercial businesses (Morse and Kramer, 1985, p. 67).

In the October 1986 issue of *Management Science*, Willis Greer and Shu Liao, two professors at the Naval Postgraduate School, published an article titled "An Analysis of Risk and Return in the Defense Market: Its Impact on Weapon System Competition". One of the conclusions of this study was that capacity utilization rate has a significant impact on the variation of defense business profitability (Greer and Liao, 1986, p. 1259). This conclusion relates to this study in that capacity utilization does impact on defense contractor financial condition and should be considered as a control variable.

Another study of defense contractors is an annually updated report for the Assistant Secretary of the Navy (Research, Development, Acquisition) by RRG Associates entitled *Financial Analysis of Major Defense Contractors 1977-*

1989. This report is essentially a compilation of the annual reports and selected financial ratios of twenty-three defense contractors. The number of companies in the report has varied due to acquisitions and mergers over the period. Some aggregate data on return on sales, return on assets, and reinvestment rates is calculated for the defense contractors and compared with commercial business ratios. However, little analysis other than the presentation of the raw data of the individual firms is presented.

In 1991 while working for the Center for Naval Analysis, Michael Treglia wrote a research memorandum titled "Financial Analysis of the Major Defense Contractors." In this paper, the financial performance of twelve major DoD prime contractors from 1984 to 1989 was analyzed. Nine financial ratios of the twelve prime contractors were aggregated and compared with similar nonfinancial corporate business data. Relative performance of each individual firm was then provided. His conclusions were: (1) the major DoD prime contractors had trouble adjusting to the declines in DoD spending in the second half of the 1980's; (2) low returns by these firms has made their ability to attract equity financing more difficult; (3) increased debt by the firms has raised the cost of financing for these firms; and (4) with decreased DoD procurement, the trend will lead to fewer resources and fewer firms in the defense industry. (Treglia, 1991, p. 29)

2. Financial Ratio Reviews

The literature review on financial ratios was conducted to assess which measures of performance would best capture the financial condition of the defense contractors. A general overview of financial ratios was conducted and followed by a more detailed review of studies on financial ratio analysis.

At first, a general review of frequently used financial ratios and what each measured was conducted. For this portion, three sources were consulted which included: (1) *Financial Accounting: An Introduction to Concepts, Methods, and Uses* by Sidney Davidson, Clyde Stickney, and Roman Weil; (2) *Corporate Financial Reporting and Analysis* by David Hawkins; and (3) *Financial Management Theory and Practice* by Eugene Brigham and Louis Gapenski.

The financial ratio literature review was then extended to determine which of the numerous available ratios would apply to this study. Three articles were utilized to assist in determining the classification, number, and types of ratios that would be most useful in assessing the financial condition of a firm.

The first article was "The Stability of Financial Patterns in Industrial Organizations" by George Pinches, Kent Mingo, and J. Kent Caruthers (Pinches, et al., 1973). This article developed empirically based classifications of financial ratios and measured the long-term stability of these classifications from 1951-1969. Seven classifications were developed based on multi-variate analysis using data from COMPUSTAT tapes[3] to include: (1) Return on Investment; (2) Capital Intensiveness; (3) Inventory Intensiveness; (4) Financial Leverage; (5) Receivables Intensiveness; (6) Short-term Liquidity; and (7) Cash Position.

The second article consulted was "The Hierarchical Classification of Financial Ratios" by the George Pinches, Kent Mingo, and Arthur Eubank, and J. Kent Caruthers (Pinches, et al., 1975). This study differed from the earlier Pinches, et al., study in that short-term stability of financial ratio groups was analyzed from 1966-1969. Again a COMPUSTAT tape was utilized for the study. A hierarchical classification of the ratios in each of the seven classifications based on factor loading (correlation with the classification) was developed. Three conclusions from this article pertain to this thesis: (1) some financial ratios are similar and can be grouped into classifications; (2) a selected set of financial ratios can be utilized to represent nearly all aspects of the condition of a firm; (3) the financial ratios that are selected should possess the desired predictive significance.

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[3] COMPUSTAT is a computer data base of financial information on thousands of publicly traded companies updated yearly and produced by Standard & Poor's Services, Inc.

The third article reviewed was "An Empirical Analysis of Useful Financial Ratios" by Kung Chen and Thomas Shimerda (Chen and Shimerda, 1981). This study analyzed several other financial ratio studies including the above mentioned Pinches, et al., studies. The main conclusions were: (1) financial ratios can be classified by a substantially reduced number of factors; (2) the ratios classified by the same factor are highly correlated, and the selection of one ratio to represent a factor can account for most of the information provided by all the ratios of that factor; (3) inclusion of more than one ratio from a factor leads to multicollinearity and distorts the relationship between dependent and independent variables; (4) concerted effort should be applied to selecting the most representative ratios of these factors, not necessarily the ratio with the highest absolute factor loadings.

3. Financial Condition Models

Three different models which provide a measure of the financial condition of a firm were reviewed to determine which model would be applicable to this study. The three models were the Altman bankruptcy model, the Dagel and Pepper model on the financial distress of DoD hardware contractors, and the Zavgren vulnerability logistic model. Each model relies on several individual financial ratios and combines values for those ratios into a single summary index or indicator of the financial health or condition of a firm.

Altman described his model of corporate bankruptcy prediction in a classic article in the September 1968 issue of the *Journal of Finance* (Altman, 1968). This model was slightly modified for easier use in his 1983 book entitled *Corporate Financial Distress* (Altman, 1983). His model only captures two of the ratio classifications in the Pinches, et al. studies and has two less utilized ratios, retained earnings over total assets and market value of equity over book value of total liabilities. A better model to determine overall financial condition for a defense firm was desired for this thesis.

In 1989 while working for the Naval Center for Cost Analysis, Harold Dagel and Ranae Pepper wrote an unpublished paper entitled "A Financial Distress Model for DoD Hardware Contractors" (Dagel and Pepper, 1989). They developed a model for assessing the financial health of DoD contractors to be used as a predictor of potential financial distress. The paper estimated the model accuracy in predicting financial distress at 93 percent.

The Dagel and Pepper model has the benefit of being developed for a DoD contractor sample which would make it suitable for this study on DoD contractors. The one drawback in this model is that it has six variables which represent only three of the Pinches, et al., seven classifications. The Dagel and Pepper model has four variables which reflect liquidity. This may be justified for predicting financial distress; but to determine overall financial condition for a firm, it was originally felt that a model which covered more aspects of the firm may be better suited for this thesis. However, the financial condition of the defense contractors selected for analysis in this thesis was determined using the Dagel and Pepper model primarily because the model was based on DoD contractors.

Zavgren used logistic analysis to develop a model utilizing one ratio from each of Pinches, et al., seven classification factors to predict failure in firms (Zavgren, 1985). The model was based on data from COMPUSTAT and was not defense industry specific, but the sample was limited to American firms. This model was originally selected as the basis to determine the financial condition of the defense contractors since it utilized the most complete set of components to develop a "snapshot" view of firms.

4. Literature Review Summary

In summary of the literature review, major accounts of the defense budget have varied over the past sixteen years in a measurable and significant way. There are numerous indicators that are used as measures for defense spending. The one most promising for this study is the amount of annual DoD prime contract awards.

The firms listed as top defense contractors do not drastically change from year to year. When change does occur, it is normally due to acquisitions or mergers among the top defense contractors. The top defense contractors, as a group, garner a significant portion of DoD contract awards each year.

No known studies have attempted to directly link the financial condition of defense contractors to the amount of defense spending, although numerous studies have been performed on defense contractors profitability. Two of the reviewed models were selected as possibly providing the best indication of the financial condition of defense contractors for this study, the Zavgren model and the Dagel and Pepper model. The Zavgren model was chosen since it encompasses the widest array of financial aspects of the models reviewed. The Dagel and Pepper model was also selected since it was derived specifically for DoD contractors.

B. HYPOTHESIS

Based on the literature review, it was hypothesized that a relationship exists between the amount of defense spending and the financial health of defense industry companies. The relationship hypothesized was linear and positive such that as defense spending increases, the financial health of major defense contractors increases.

The government defense market is best characterized as a monopsony where the government is the only buyer of the products that several companies manufacture. Due to the high barriers to entry, which include technology and cost of plant equipment at the upper end of the prime contract market, the number of contractors remains fairly constant.

Companies enter and compete in markets where they will be able to continue as a going concern. Moreover, the assumption "that firms seek maximum economic profits has a long history in economic literature." (Nicholson, 1989, p. 352) When defense spending increases, the amount of business that the defense contractors receive in the monopsony should increase. It was hypothesized that this increase in defense spending improves the financial condition of these defense contractors.

This is the overall hypothesis of this thesis. The hypothesized effect of other independent and control variables are discussed as each is developed and analyzed.

C. THE SAMPLE

This section details the source and process used to select the sample of DoD contractors for this thesis. In selecting the sample, a representative and manageable number of contractors was desired.

The primary source used for selecting the major DoD prime contractors was the DIOR annual *100 Companies Receiving the Largest Dollar Volume of Prime Contract Awards*. This report ranks the major DoD contractors, with each contractor subsidiary included, by order of dollar amount of DoD prime contracts awarded in a given fiscal year. Several facts and statistics preface the ranking such as:

1. changes in the top 100 contractors from the previous year,
2. cumulative percentages of total prime contract awards for various rankings,
3. procurement categories,
4. and the top twelve contractors and their major products.

The method used in selecting the representative sample of top defense contractors was to determine the twenty largest defense prime contractors over the past twenty years based on the DoD contract awards. This select group represents those contractors receiving the highest dollar value of defense contracts and could be classified as the top stratum in a stratified sample.

Two companies out of the original twenty selected were deleted leaving the sample with eighteen contractors. The first company deleted was Hughes Aircraft since it was acquired by General Motors in 1986 and therefore did not have complete independent data for the period covered.

Tenneco, Inc., was the second company deleted from the sample. It is a widely diversified conglomerate which has a large investment in oil and gas pipelines. This investment causes the Tenneco capital structure to be significantly different from the other companies in the sample since it holds more debt capital than other companies in the sample.

This high reliance on debt capital caused the financial health values determined from the Dagel and Pepper model to indicate that Tenneco was in a "bankrupt" condition for the past sixteen years. This was not the case, so Tenneco was dropped from the sample population to prevent the negative indication from affecting the sample. The final eighteen companies selected and used for the sample are listed in Table 1. The abbreviation for each company that is used in latter tables is in parenthesis.

The cumulative percent of DoD sales from 1975 to 1990 for the individual companies ranges from a low of 1.9 percent for General Motors to a high of 86.5 percent for Grumman. The percent of DoD sales was determined from the amount awarded in a given fiscal year as stated in the DIOR annual top 100 contract award report divided by the selected contractor total revenues for the year.[4]

TABLE 1

SELECTED DOD CONTRACTORS IN SAMPLE

Boeing (BOE)
General Dynamics (GD)
General Electric (GE)
General Motors (GM)
Grumman (GRU)
Honeywell (HON)
IBM (IBM)
Litton Industries (LIT)
Lockheed (LOC)
LTV (LTV)
Martin Marietta (MAM)
McDonnell Douglas (MCD)
Northrop (NOR)
Raytheon (RAY)
Rockwell International (ROC)
Textron (TEX)
United Technologies (UT)
Westinghouse (WES)

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[4] This measure of DoD sales has some "noise" which will be discussed later under the limitations and problems encountered section.

D. CONSTRUCTS

This section provides a discussion on the dependent variable of contractor financial condition, how the financial condition was determined, and which independent and control variables were used in this study.

1. Dependent Variable

This study was designed to measure the dependent variable of contractor financial health by using at least one of the three financial distress models that were reviewed earlier in section A.3. of this chapter. The model by Zavgren provided the best overall financial picture since it utilized seven variables, each depicting a different dimension of financial condition, to develop one number to characterize the overall condition of each contractor. Although all the companies utilized in constructing the Zavgren model were American firms, they were widely diversified and not industry specific. Since each industry of U.S. business normally possesses specific financial characteristics, a model developed on the industry of concern would provide a more characteristic description of that industry.

In developing their model, Dagel and Pepper did not utilize financial ratios that capture the entire range of financial dimensions. This model is heavily weighted toward the liquidity of a firm since four of the six variables relate to the liquidity position of the firm. The major viability of this model is that it was developed as a predictor of financial distress for defense industry contractors. In fact, eleven of the eighteen contractors used in this thesis sample were identical to contractors utilized in constructing the Dagel and Pepper model.[5]

The advantages and disadvantages of these two models are so unique that both approaches were used to calculate financial health for the contractors in this study. It was felt that strong cases could be made for each model.

a. Zavgren Model

The Zavgren logit model is based on the equation:

$$P(x)=F(\beta_0+\overline{\beta X_i})=\frac{1}{1+e^{-(\beta_0+\overline{\beta X_i})}} \qquad (1)$$

P(x) is the probability of financial distress for a firm. The Zavgren model uses seven variables which are:

X_1 = Inventory/Sales
X_2 = Receivables/Inventory
X_3 = Cash/Total Assets
X_4 = Quick Assets/Current Liabilities
X_5 = Total Income/Total Capital
X_6 = Debt/Total Capital
X_7 = Sales/Net Plant

For one year prior to failure, the coefficients were determined to be:

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[5] The Dagel and Pepper model utilized 29 bankrupt and 29 comparable non-bankrupt firms for their model. Ten non-bankrupt were identical and one bankrupt firm was identical.

$\beta_0 = -0.23883$ $\beta_1 = 0.00108$
$\beta_2 = 0.01583$ $\beta_3 = 0.10780$
$\beta_4 = -0.03074$ $\beta_5 = -0.00486$
$\beta_6 = 0.04350$ $\beta_7 = -0.00110$

The ratios in the Zavgren model were determined based upon the COMPUSTAT data tapes. To determine the specific data items used to construct each ratio, three references were required which included: the 1985 Zavgren article; the 1973 Pinches, et al., article; and the *Industrial COMPUSTAT Manual*. The degree of depth that the COMPUSTAT data base possesses was not able to be duplicated, but proxy measures were used instead to approximate the data that a COMPUSTAT data base would provide. Appendix I provides a comparison of the COMPUSTAT definitions for specific data items, the Dagel and Pepper definitions, and the measures actually used in this study.

A common log transformation was applied to all financial ratios for the Zavgren model. Although the Zavgren article did not specifically state that this was performed, the article was based on the two Pinches, et al., articles which did state "that a common log transformation was applied to all financial ratios to improve normality, reduce outliers, and improve homoscedasticity of the distributions." (Pinches, et al., 1973, p. 390 and 1975, p. 296) It was assumed that

Zavgren also performed this transformation on ratios prior to developing her model.[6]

Performing common log transformations on the financial ratios caused a unique problem. The return on investment (total income/total capital) and financial leverage (debt/total capital) ratios were negative for some of the contractors during certain years. Since a common log cannot be taken of a negative number, a mathematical operation was utilized to ensure the log operation could be performed on all ratios.[7] This operation did cause a distortion in the data by giving the negative number a larger effect than it otherwise would have had, but it did provide the indication that the firm has an unfavorable condition which was felt to be more important.

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[6] The Zavgren value for the financial health of a firm was determined with and without the common log transformation. With the common log transformation, there was more variability and range for the sample measures (0.5046 to 0.5312) as opposed to without the log transformation (0.5855 to 0.5982). Both versions were correlated with the Dagel and Pepper data. With the log transformation, the correlation was 0.703. Without the log transformation, the correlation was 0.050. Therefore, since the two models were designed to tell roughly the same story about the financial condition of the given set of firms, the correlation should have been relatively high between outputs of the two models. The log transformed financial ratios were thus used for the Zavgren model inputs.

[7] This operation was as follows:
ROI = Return on Investment
RFAC = ROI/ABS(ROI) which would equal +1 if ROI > 0 and equal -1 if ROI < 0.
ROI2 = [log(ROI * RFAC)] * RFAC where the log operation is always possible and a negative sign is assigned to ROI2 if ROI < 0.

Zavgren then developed units called nits to describe the condition of the firms.[8] The equation used to describe the financial health of a firm was:

$$h(1-p) = \ln\left(\frac{1}{1-p}\right) \tag{2}$$

where ln is the natural logarithm and p is the probability of failure determined from equation (1).[9]

b. Dagel and Pepper Model

The Dagel and Pepper financial distress model for DoD contractors was developed from 29 bankrupt and 29 nonbankrupt publicly held firms using the multi-variate statistical procedure of discriminant analysis. The linear equation which resulted from their study is:

$$Z = 1.54 - 6.48X_1 + 4.61X_2 - 0.41X_3 + 9.31X_4 - 5.40X_5 + 1.63X_6 \tag{3}$$

where:

X_1 = Total Debt/Total Assets
X_2 = Cash Flow/Total Debt
X_3 = Current Assets/Current Liabilities
X_4 = Quick Assets/Total Assets
X_5 = Working Capital/Total Assets
X_6 = Net Sales/Total Assets

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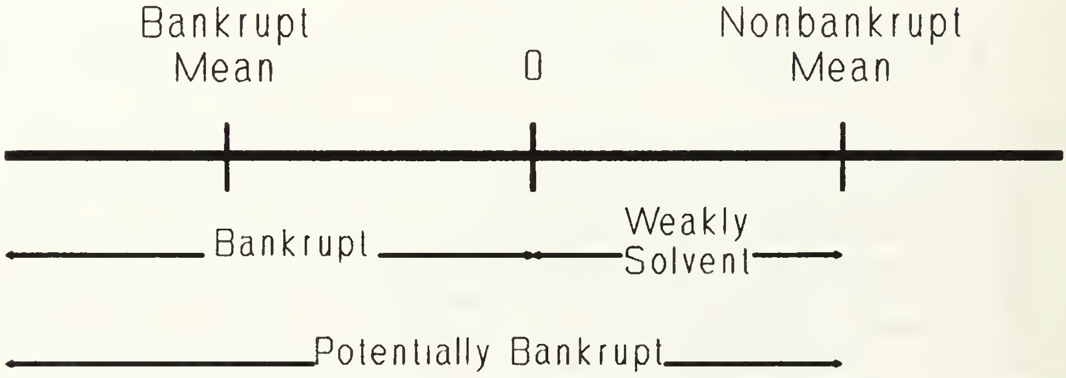
[8] The development of this measure is beyond the scope of this paper. Briefly, nits are based on the Shannon Entropy Theory which was developed to analyze information flow in a network. The entropy is the degree of uncertainty over the occurrence of an event. (Zavgren, 1985, p. 30,36-40)

[9] As would be expected, the correlation between p and $h(1-p)$ is very high (0.998); therefore either measure would provide nearly identical results for further correlations or regression models.

A bankrupt firm would have $Z < 0$, and a nonbankrupt firm would have $Z > 0$.

Dagel and Pepper suggested using the classification scheme in Figure 9 after verifying and validating their model. This figure adds the classifications of "weakly solvent" to firms with Z-scores between zero and the nonbankrupt mean and "potentially bankrupt" to all firms with Z-scores less than the nonbankrupt mean. This was used to increase the reliability of their model in classifying the financial condition of each contractor. For this study, the only relevant information from the Dagel and Pepper model is the score developed from the Z-equation, not the classification.



Source: Dagel and Pepper, 1989

Figure 9. Dagel and Pepper Classification Scheme

2. Independent Variables

In selecting the independent variables to represent DoD spending, several possible candidates emerged from the literature review. These candidates included: (1) defense budget authority, (2) defense budget outlays, (3) amount of DoD prime contract awards, and (4) the sum of the procurement and RDT&E account outlays. Also considered were each of these four measures stated as a percentage of GNP and as a percentage of national outlays. Two more possibilities were the amount of DoD prime contract awards and the sum of the procurement and RDT&E account outlays each as a percentage of DoD outlays.

All the percentage measures were quickly eliminated as they added the variability of the denominator into the measure. This added variability of the denominator clouds the analysis when attempting to isolate the effect DoD spending has on the financial condition of these contractors.

Budget authority was not selected as the best measure for two reasons. First, it does not represent the actual amount spent during the year. Second, it includes extra distortions since it also captures the variability of the O&M and Military Personnel accounts. Although it represents the actual amount spent, budget outlays also include the distortions of the varying amounts of other DoD accounts that do not impact on the defense contractors.

The sum of the procurement and RDT&E accounts removed the distortions of the variability of other DoD accounts that existed in the DoD outlays and DoD authority measures. This measure was selected for further analysis.

The amount of prime contracts awarded each year was another measure that was selected for further analysis. There are three reasons why this measure has merit although it does have the distortion that some of the contract awards are not earned or paid to the contractor for several years due to multi-year features.

First, the contractors that were selected in the sample have been defense contractors for years prior to and throughout the entire period covered by this study. This continuity tends to normalize the effect that multi-year contracts have on the amount of DoD business. Second, it can be argued that the financial condition of a firm is impacted by the expected future demand for its products and hence its future expected earnings potential. Since prime contracts are viable for several years, contractor expected future earnings, hence its market value and financial condition, may be more accurately predicted. Finally, the amount of DoD prime contracts awarded was divided by the total revenue of each contractor to construct a measure of the percentage of business of each contractor that was DoD related.

Along with the constant dollar amounts of the procurement and RDT&E accounts and the prime contracts awarded each year, the yearly change of these measures was considered a separate independent variable. The basis for this determination was that as defense spending changes, the prime contractors receive proportionately more of the change in procurement or prime contract dollars.

The change in DoD spending level selected depended on the independent measure of DoD spending selected. For example, if the DoD spending measure selected was the amount of DoD prime contracts awarded in a year, then the change in DoD spending level measure selected was the change in DoD prime contracts awarded from year to year.

3. Control Variables

Several control variables were analyzed to determine their significance to this study on the financial condition of defense contractors. The control variables reviewed include GNP, change in GNP, inflation, prime rate, industry capacity utilization, and the percent of DoD business for each contractor (measured by dividing the amount of DoD prime contracts by total revenue for each contractor).

To provide a meaningful and useful model, a limited number of control variables had to be selected. Multicollinearity also had to be considered to prevent different control or independent variables from reflecting nearly identical information. Several considerations that bear on the choice of control variables are discussed next.

Inflation can impact the financial condition of a contractor depending on how much of the inflated prices the contractor absorbs and how much is passed on to the buyer. Also if fixed-price contracts are considered, the accuracy of the inflation estimates and stated price adjustment clauses affect the profitability of the contractor (DFAIR, 1985, p. V-52).

The prime interest rate can impact the financial condition of a contractor by increasing interest expenses as the prime interest rate rises. An increase in the prime interest rate would then cause net profit to decline if *ceteris paribus* is applied.

In the overall economic picture though, both the inflation rate and the prime rate effects are reflected in the GNP. To limit the number of control variables, it was assumed that the GNP measure selected incorporated to some extent the inflation and prime interest rate effects. Only one GNP measure, either the constant dollar GNP or the change in GNP, was needed for the model development. Later analysis showed that constant dollar GNP was highly correlated to the defense spending independent variables. Therefore, the change in GNP was used to represent the effects of GNP on the dependent variable.

The control variables of capacity utilization and percent DoD business were also considered in the analysis.

From the Greer and Liao study (1985), it was expected that as capacity utilization rose, the financial condition of the contractors would have also risen. Based on the GAO report (1986) and the Morse and Kramer thesis (1985), it was hypothesized that as percent DoD business increased for a firm, the financial health of the firm would have improved; but the more recent Treglia study (1991) places some doubt on this hypothesis in the last half of the period between 1980 and 1990.

Further discussion and development on which independent and control variables were selected for the development of the model from those remaining is located in Chapter IV.

4. Summary of Variables for Analysis

The following variables were selected for further analysis and development of the model:

Dependent Variables:
  Dagel and Pepper Z-scores
  Zavgren nits values

Independent Variables:
  Amount of DoD prime contracts awarded
  Sum of procurement and RDT&E accounts
  Change in DoD spending level

Control Variables:
  GNP or change in GNP
  Capacity utilization
  Percent DoD business for each contractor

E. DATA

In the ideal case, data would be standardized and accurate. However, such data is often difficult, expensive, or impossible to obtain. There will therefore be "noise" in most sets of data. It is the analysts responsibility to minimize the effects of the "noise".

In obtaining financial information on the sample companies over the sixteen-year period, the primary source for the company data was the yearly Security and Exchange Commission (SEC) 10K filing and annual report for each company. Secondary sources were used when the SEC 10K or annual report was not available. The secondary sources utilized included *Moody's Industrial Manual*, *Moody's Public Utilities Manual*, *Standard & Poor's Corporate Record*, and the DIALOG computer data base.

The SEC 10K reports are required by the Securities and Exchange Commission on a yearly basis by each company. Most companies submit their annual report along with certain supplementary information to fulfill the requirement. The accounting and reporting practices of each contractor varies slightly since the Financial Accounting Standards Board only provides general guidelines for financial reporting. The inconsistencies in accounting and reporting affect the comparability of the data.

Moody's Industrial Manual and *Moody's Public Utilities Manual* compile much of the same information on companies that is stated in annual reports, but in a condensed format. These annually published manuals show financial information and bond ratings for hundreds of companies across all segments of industry.

The *Standard & Poor's Corporate Record* also provides annual report summary data on hundreds of companies, but it only covers the previous two years. This reference contains a summary of the latest company annual report data.

All the company data was assimilated and standardized as conditions warranted. The different presentations of the financial data between the various references were reconciled. Over the sixteen year period, companies varied their annual report presentations which were also reconciled to maintain continuity. One noted difference between the data set in this study compared to the Zavgren data set is that the Zavgren data set used COMPUSTAT data. This study attempted to replicate, with as much accuracy as time allowed, the data in COMPUSTAT.

The company data items that were collected and organized for this study are listed in Table 2. This format was developed after reviewing the financial data organization techniques used by Robert Morris Associates in its *Annual Statement Studies* and the United States Bureau of the Census

TABLE 2

COMPANY FINANCIAL DATA COLLECTED

Income Statement

- Net Sales
- Other Revenue (i.e. from major investments)
- Other Income (net) (i.e. interest income)
    - Total Revenue
- Cost of Goods Sold
- Selling, General, and Administrative Expense
- Other Expenses (i.e. research and development)
    - Total Expenses
- Minority Interest
    - Earnings Before Interest and Tax (EBIT)
- Interest Expense
    - Earnings Before Tax (EBT)
- Tax Expense
- Extraordinary Gain/Loss
    - Net Income

Miscellaneous

- Depreciation

Balance Sheet

- Cash
- Marketable Securities
- Receivables
- Inventory
- Other Current Assets
    - Total Current Assets
- Gross Property, Plant, and Equipment
- Depreciation
- Net Property, Plant, and Equipment
- Other Assets
    - Total Noncurrent Assets
    - Total Assets
- Short-term Debt
- Current Liabilities
- Long-term Debt
- Deferred Taxes
- Other Debt
    - Total Noncurrent Liabilities
    - Total Liabilities
- Minority Interest
- Preferred Stock
- Common Stock
- Additional Paid-in Capital
- Retained Earnings
- Foreign Currency Translation/Other
- Treasury Shares
    - Total Equity
    - Total Liability and Equity

(Items indented were summed from non-indented items.)

in its *Quarterly Financial Report*. The data was stored in a Microsoft Works data base for ease of manipulation and handling.

Prior to developing and collecting the list of required data, the data used in the Dagel and Pepper study and the Zavgren study was reviewed to enable the data collected for this study to be as similar to the data in those studies as time would permit. The calculated Dagel and Pepper Z-scores, the Zavgren financial health measures, and the percent DoD business for the contractors are shown in Appendix II.

The ability to replicate the Dagel and Pepper data was much higher than the ability to replicate the COMPUSTAT data. Therefore more reliability was placed in the data, the model, and financial condition scores from the Dagel and Pepper model.

The primary source of information for the U.S. Government budgetary information was the *Budget of The United States Government, Fiscal Year 1992, Historical Tables* (*Budget*), which is developed by the Office of Management and Budget. Other fiscal year *Historical Tables* by OMB and various volumes of *Statistical Abstracts of The United States* (*SAOUS*) were also used to extend certain data sets.[10]

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[10] *SAOUS* uses the OMB *Budget* as its source for tables on government spending.

The *Economic Indicators*, a U.S. Government Printing Office monthly publication, was used as the source for the economic data on the change in GNP, prime rates, and inflation.[11]

The capacity utilization rates for this study were obtained from the monthly *Federal Reserve Bulletin*. The capacity utilization rates used in the Greer and Liao study (1986) were from the aerospace component industry group, which is a subgroup of the durable goods category. Since the aerospace component industry capacity utilization rates could not be duplicated from the available sources, the durable goods capacity utilization rates were used instead.

F. ANALYSIS OF RELATIONSHIPS

This section discusses the plan that was developed for structuring the relationships to be tested between the variables. The relationships were examined using the statistical techniques of correlation and regression. The following linear regression equation was used:

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[11] The OMB *Budget*, *SAOUS*, *Economic Indicators*, and *Survey of Current Business*, a U.S. Department of Commerce monthly publication, are identical in information where they overlap except GNP. The GNP numbers in the OMB *Budget* are the only different figures from the other sources. The OMB GNP numbers were utilized in the background discussion in Chapter I. The change in GNP from the *Economic Indicators* was used in Figure 1, Chapter I and in the analysis since OMB does not publish that number separately.

$$Y_i = \alpha + \beta_1 x_{\ell i} + \ldots + \beta_\ell x_{\ell i} + \epsilon_i$$

where:

Y_i = dependent variable
α = intercept
β_ℓ = independent variable coefficient
$x_{\ell i}$ = independent variable
ϵ_i = error variable
K = number of independent variables
i = ith set of n sets of observations

In order to determine the impact that the independent variable of defense spending has on the dependent variable of financial condition, relationships were tested on two levels. First, relationships between aggregate defense spending and aggregate financial condition of the contractors were examined. The objective here is to draw broad conclusions about total defense spending and the overall financial health of the defense contractor industrial sector.

The aggregate financial condition of the defense contractors (FH_A) was expected to improve as aggregate defense spending (DS_A) increased, due to the contractors receiving higher business volume. This should be reflected in positive beta coefficients for the independent variables of level of defense spending (DS_A) and the change of defense spending (DELTA DS_A).

The defense contractors also have non-defense related business; therefore, their financial health is also impacted by the state of the overall economy. To account for this influence on the financial condition, the change in GNP (DELTA GNP) was selected as a control variable. If the change in GNP was positive, the financial condition was expected to improve. This should be reflected by a positive beta coefficient for the change in GNP. Other broad trends that occurred could be accounted for by using the year (YEAR) as an independent variable to remove the trend. These relationships are expressed as a function by:

$$FH_A = f(DS_A, \text{DELTA } DS_A, \text{DELTA GNP, YEAR})$$

Second, relationships between the financial health of each individual contractors and DoD spending specific to that contractor were examined. The objective here is to draw conclusions about the responsiveness of financial conditions of specific firms to DoD spending directed toward the firms.

The financial condition of each individual contractor (FH_P) was expected to improve as each contractor increased its amount of DoD business due to the higher business volume. This should be reflected in positive beta coefficients for the independent variables of individual contractor level of defense prime contract awards (PC_P) and the change of the prime contract awards (DELTA PC_P).

Since the contractor competes in the defense industry, the total amount of defense spending for the defense industry (DS_A) and the change in the amount of defense spending in the defense industry (DELTA DS_A) were additionally expected to impact the financial condition of the individual contractors. This should be reflected in positive beta coefficients for the aggregate measure of defense spending (DS_A) and the change of the aggregate defense spending level (DELTA DS_A).

Each contractor has non-defense related business. The financial condition of the individual contractor is therefore also impacted by the state of the overall economy. To account for this influence on the financial condition of the individual contractor, the change in GNP (DELTA GNP) was selected as a control variable.

This analysis was conducted in two modes. First, broad trends for each contractor were controlled for by using the year (YEAR) as a trend remover. Second, broad trends for each contractor were not removed by eliminating the year as an independent variable. These relationships are expressed as a function by:

$$FH_P = f(PC_P, \text{DELTA } PC_P, DS_A, \text{DELTA } DS_A, \text{DELTA GNP}, \text{YEAR})$$

At the individual contractor level, one further question analyzed was whether the sensitivity of the financial condition of the contractor to DoD spending is related to percent of DoD business for the contractor. If percent DoD business is greater, the financial condition of the contractor should be more sensitive to DoD spending. Therefore, the greater sensitivity should be reflected in higher beta coefficients for the defense spending variables (PC_P, DS_A) and the change in DoD spending variables (DELTA PC_P, DELTA DS_A).

The discussion of the actual results and analysis of these relationships is in Chapter IV.

G. STATISTICAL TECHNIQUES

The seventh step in this thesis entailed calculating and analyzing data in three parts which included:

1. Providing descriptive information on the dependent, independent, and control variables individually by use of means, standard deviations, and ranges.
2. Providing a tabular portrayal of the relationships between the variables using correlation techniques.
3. Developing a formal model of the relationships between the dependent and independent variables by use of regression techniques taking into consideration the control variables.

This procedure and the results are provided in Chapter IV.

H. PROBLEMS/LIMITATIONS ENCOUNTERED IN STUDY

There is no absolute measure or standard in determining the financial condition or health of a company. A number of generally accepted techniques for determining the financial condition of a company include common size analysis and Du Pont analysis. In these methods, various ratios of a firm are compared with industry standards to relate the condition of each firm with that of the industry which the firm is principally engaged. Although a majority of the firms studied are in the aerospace field, most of these companies are diversified and have substantial income from operations outside their principal business.

A number of studies have been conducted relating defense business financial ratios to aggregate totals of durable goods manufacturers or nonfinancial corporate businesses. Most of these studies have centered around just defense contractor profit. This study used an accepted failure prediction model to enable the use of several financial ratios to produce one "measure" of the financial condition for a company.

Several limitations that were encountered during this study are discussed below. This list is not exhaustive, but does include the major items that created "noise" in the collected data. Ideally, no "noise" is desirable in a data set. Research constraints of time and finances resulted in these limitations.

1. Timing

A fundamental problem encountered when comparing financial data from different sources is the "timing" difference between the sources. In this study, the DIOR list of top contractors is based on the fiscal year. The government fiscal year is from 1 October to 30 September.[12]

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[12] The government changed its fiscal year from 1 August-31 July to 1 October-30 September in 1976. A three-month interim fiscal period was used for budgetary measures during the switch in fiscal years.

Most contractors use fiscal years which coincide with the calendar year. This creates a timing difference in relating the prime contract awards and DoD spending to the financial condition of a firm.

Another factor adding to the timing discrepancy is that some of the contract awards are multi-year awards which do not result in substantial revenue to the firm until two or three years later. The multi-year awards allow for the purchase of long lead items and major plant equipment. This factor affects those contractors that build and deliver major items which require long production periods such as ships, missiles, satellites, and aircraft.

Some of the timing distortions are minimized when data for the individual firms is aggregated. When individual firms are analyzed separately, these distortions have more unavoidable effects on the outcome. Most of the firms considered in this thesis sample have had a constant annual growth in the value of DoD contracts received.[13] This constant growth in DoD contract awards reduces the multi-year effect since these same contractors have been receiving contracts prior to and continuously through the period covered in this thesis sample.

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[13] One exception to this is Tenneco, Inc., which has been more cyclical, but with an increasing trend, due to large contract awards in the years that it received aircraft carrier contracts.

2. Procurement Policy Changes

From 1975 to 1990, the United States government made several changes in its policy of making progress payments to defense contractors. The rate at which the government made progress payments has affected the amount of borrowing required by the contractors. This in turn affected their liquidity and profitability.

Another procurement policy shift during this period was that DoD increased the use of fixed-price contracts. The goal of this policy was to increase contractor efficiency, control costs, and increase the amount of financial risk for major defense contractors. As a result of this policy change, several contractors experienced losses on fixed-price contracts.

These procurement policy changes demonstrate the risks involved in competing in the defense industry which can affect the financial condition of a firm. The limitation these changes impose on this study is that changes in these policies during this period were not isolated to determine their affect on the financial condition of contractors.

3. Other Government Agency Contracts

Many government contractors list in their annual reports or SEC 10K filings the amount or percentage of their revenues that is based on government sales. This amount is not broken down by specific government agency. The major government agency making purchases from the sample contractors used in this thesis has been the DoD. Currently as the DoD budget shrinks, more contractors are using their strengths and resources to increase their potential for contracting with other government agencies such as the National Aeronautics and Space Administration (NASA) and the Federal Aviation Administration (FAA). This was a limitation in that not all the sample contractors listed percent government sales in their annual reports, and the percent government sales that were listed included other government agency procurement actions.

Sales of military equipment to foreign governments is conducted under the Foreign Military Sales (FMS) program. Since DoD administers this program for the foreign customers, many contractors include FMS under their government sales totals. The foreign government end items are produced and delivered from the same production lines building the DoD end items. While FMS procurement is included in the annual government sales figures of the sample contractors, it does not reflect the DoD spending impact on the financial condition of the contractors. Therefore, another problem in using the government sales figures was that it added distortions which could not be accounted for.[14]

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[14] Not all defense contractors state the amount or percent of defense or government business in their annual reports. Correlation tests were performed between the percent DoD business based on DoD prime contract awards/total revenues and

4. Accounting Changes

Over the period studied, a number of accounting changes have occurred which have influenced the financial statements of the individual contractors. Three major accounting changes were Financial Accounting Standards (FAS) Nos. 52, 94, and 96.

Financial Accounting Standard No. 52, Foreign Currency Translations, required firms to change their treatment of foreign operations with the foreign exchange translation adjustments being accumulated as a separate component of stockholder equity. Most of the firms in the sample adopted this FAS in 1982. No special considerations were made to the data to smooth the effects of this change.

In 1987, most companies adopted FAS No. 96, Accounting for Income Taxes, which changed the method of computing income taxes from the previously used "deferred method" to the presently used "liability method". No special considerations were made to the data to smooth the effects of this change.

Most companies which have financial service subsidiaries adopted FAS No. 94, Consolidation of All

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percent government sales (correlation = .746) and the amount of DoD prime contract awards and amount of government sales (correlation = .846). From the sample contractors, there were 198 of 288 (18 contractors by 16 years) that this correlation check is based on which is 69 percent of the sample. Neither pair of measures is without its disadvantages. The percent DoD prime contract awards/total revenue was used since this data was available for the entire period whereas the percent government sales data was not always available.

Majority-Owned Subsidiaries, in 1988. This FAS changed how companies report subsidiaries, especially financial subsidiaries. Before 1988, financial subsidiaries were normally accounted for on an equity basis. The equity basis method treats subsidiaries as an "investment" on the balance sheet and "other income" on the income statement. The use of the equity method was due to the financial operations of the parent company being so different in nature and essentially unrelated to the operations of the "other" subsidiaries. With FAS No. 94, the financial subsidiaries were consolidated with all other subsidiaries. All accounts of the subsidiaries were thus added to each respective account on the financial statements of the parent company. Adjustments to the company data were made where possible to bring these financial subsidiaries back on the equity basis for the last three years.

5. Tax Policy Changes

Several tax changes occurred from 1975 to 1990 which affected the financial condition of companies. The most notable changes occurred in the 1986 Tax Recovery Act. Although the 1986 Tax Recovery Act did lower tax rates which increased earnings, it also changed the treatment on revenue recognition on long-term contracts. This essentially decreased the amount of tax deferral allowed and hence had a negative effect on cash flows. Two other provisions in the

1986 Tax Act increased the contractors tax liability by eliminating the investment tax credit and decreasing depreciation allowances. (Treglia, 1991, pp. 11-12) No adjustments to the financial data were made to eliminate the effects of these tax policy changes.

6. Mergers/Acquisitions/Joint Ventures

From 1975 to 1980, numerous mergers and acquisitions were completed. Defense subsidiaries of one major defense contractor tended to be sold to another major defense contractor. No special treatment of the data was performed to smooth the fluctuations caused by such complex business combinations.[15] These actions were considered part of the operating decisions of the firm.

The DIOR top 100 contractor report lists joint ventures separately from the major company involved in the enterprise. When this was the case, each company in the joint venture was allocated an equal share of the joint contract award.[16]

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[15] Two major mergers occurred during the period which were RCA with General Electric and Hughes Aircraft with General Motors.

[16] An example of this is the joint venture between McDonnell Douglas and General Dynamics in making the Navy A-12 aircraft. In 1990, this joint venture alone was ranked thirty-third in the top 100 with $555 million of contract awards. Each contractor received $277.5 million more to their company totals.

7. Miscellany

Cash management has changed greatly over the past twenty years. These changes were due to the upward trend in interest rates and the increased use of electronic funds transfers. The increase in interest rates has pushed up the opportunity cost of holding cash. Electronic funds transfers have enabled managers to optimize cash transactions on a real-time basis. (Brigham, 1991, p. 790)

The article by Zavgren stated several items that could not be accounted for in that study. These same items could not be accounted for in this study. "These include the unmeasured qualities of assets, the creative ability of management, random events and the decisions of regulators and courts of law." (Zavgren, 1985, p. 22)

Three other commonly known problems that occur when using financial ratios for analysis are the different accounting conventions (i.e., LIFO or FIFO) and depreciation methods (i.e., ACRS, straight-line, or sum-of-the-years digits) each company uses, the effects that inflation has on inventory and depreciation,[17] and the ability of management to control the look of its financial statements by using "window-dressing" techniques.

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[17] The Financial Accounting Standards Board encourages, but does not require, companies to report inflation adjusted statements as an addendum to their required statements.

One other problem encountered in this study was the different presentations of the same basic data from various sources. In order to obtain the financial data of the nineteen companies over the sixteen-year period, a number of different sources had to be consulted. Although most of the data lines in the sources were consistent, some of the sources arranged the data in a slightly different manner. Care was used in assembling the data to minimize these differences where they existed.

8. Summary

The study of the financial condition of companies over time is inherently difficult because of accounting variations between companies, accounting changes over time, management and technology changes over time, diversification of companies into various industry segments, inflation effects on inventory and depreciation, end-of-year window dressing techniques applied to financial statements, variations in data reported by financial information organizations, and tax policy changes.

The financial condition of DoD contractors is further complicated by timing differences of reports, government procurement policy changes over time, and treatment of non-DoD government related work and Foreign Military Sales.

The accumulation of all these problems and limitations affects this study and its findings by adding "noise" to the data and the results that can not be filtered out. The exact impact of the "noise" can not be measured or known but is assumed to be minimal.

IV. ANALYSIS

This chapter explains the analysis that was performed on the data and the process used in developing the model to relate the effect that DoD spending has on the financial condition of major defense contractors. A Minitab statistical program for use on personal computers was utilized for the statistical calculations.

A. FINANCIAL CONDITION INDEX SELECTION

After the financial data was collected on the nineteen original contractors in the sample (including Tenneco, Inc.), the ratios and financial condition of the contractors were determined for both the Dagel and Pepper and the Zavgren models. Comparison of the results with what was known to have occurred with these contractors was then conducted as a logic test of the outputs from the models.

First, the Tenneco results from the Dagel and Pepper model showed that Tenneco had negative Z-scores for all sixteen years. This would have classified Tenneco as "bankrupt" for the entire period. As discussed earlier, Tenneco was dismissed from the sample because of these results.

Overall, the Dagel and Pepper Z-scores seemed to reflect what was known to be the financial condition for the remaining contractors. A litmus test of sorts was a check on LTV. LTV was classified as bankrupt by the Dagel and Pepper model during eleven of the sixteen years. LTV did have substantial financial problems throughout the sixteen years and officially declared bankruptcy on 17 July 1986.

The rest of the Dagel and Pepper Z-scores showed results where certain contractors in some years were classified as "bankrupt". Some of these "misclassifications" were attributed to the model. The Dagel and Pepper model has negative coefficients for the current assets/current liability and working capital/total assets terms which caused the Z-score to decrease as these terms increased. This is contradictory to what is normally considered correct since these ratios are normally high for healthy firms. Dagel and Pepper explained this by stating "the key point is that the discriminant model variables are not independent." (Dagel and Pepper, 1989, p. 11) They go on to explain how "a high value of X_5 [working capital/total assets] would likely be offset by a corresponding increase in the Z-score resulting from a low value of X_1 [total debt/total assets]." (Dagel and Pepper, 1989. p. 12) Terms in braces were added for clarification.

These negative coefficients are the cause for Grumman having negative Z-scores in several years. Grumman decreased current liabilities and increased current assets which resulted in negative Z-scores during some years. Recently, Grumman has not been receiving the major contracts it has had in the past such as the F-14 and A-6 contracts. Since Grumman has high revenue earnings from DoD business, it would be expected to be one of the first contractors to show a weakened financial condition in a period of decreasing defense spending.

It is important to note one other contractor, Textron. Textron showed negative Z-scores or low positive Z-scores from 1985 to 1990. Although Textron had not been in the same poor financial condition as LTV, these low scores can be explained by the purchase of AVCO by Textron in 1985 and the tripling of its debt to finance the purchase.

The significant point here is that although the Dagel and Pepper model may not have actually classified the contractors correctly as far as "bankrupt" or "nonbankrupt", the model has provided a set of data on the financial condition of the sample which has good variability. The variability is consistent with known "good" and "bad" conditions for the contractors.

All the financial health measures from the Zavgren model are close to 0.5 on the model scale of zero to one. Companies in poor financial condition should have Zavgren financial health measures close to zero. LTV, although bankrupt, had financial health measures higher than actual healthier contractors. There are two possible reasons for the Zavgren model results not being able to pass the reality checks. First, the data used in calculating the Zavgren model scores may not have been close enough to duplicate the COMPUSTAT data that the model is based on. Second, some of the ratios can provide misleading signals. For example, LTV in 1986 had a net loss and a negative total equity. This resulted in a high positive return on investment (total income/total capital) for LTV for that year when in fact its return on investment was exceedingly poor.

Since the Zavgren model did not provide any meaningful or explainable variability, this model was no longer considered in the analysis. Attention was instead directed to financial condition as measured by the Dagel and Pepper model.

Aggregate yearly Dagel and Pepper Z-scores were constructed by first calculating the yearly Z-scores for each of the eighteen contractors in the sample. The mean of the eighteen Z-scores for each year was then determined for each of the sixteen years. This mean reflected the average financial condition for the sample.

B. HYPOTHESIS TESTING

The research hypothesis (H_1) states that as DoD spending increased, the financial health of the defense contractors should have improved. The null hypothesis (H_0) is then stated such that as DoD spending increased, there should have been no systematic change in the financial health of the defense contractors. To test this null hypothesis for population correlation, Newbold states:

> It can be shown that when this null hypothesis is true and the random variables have a joint normal distribution, the random variable corresponding to *t* follows a Student's *t* distribution with (n-2) degrees of freedom. (Newbold, 1988, pp. 440-441)

To test this hypothesis, the following equations were used:

$$t=\frac{r}{\sqrt{\frac{(1-r^2)}{n-2}}}$$

$$H_0:\ \rho=0$$

$$H_1:\ \rho>0$$

$$\text{Reject } H_0 \text{ if } \frac{r}{\sqrt{\frac{(1-r^2)}{n-2}}}>t_{n-2,\alpha}$$

where:

n = sample size (16 years for this analysis)
r = sample correlation coefficient
ρ = population correlation coefficient

The sample correlation (r) between the aggregate yearly Dagel and Pepper Z-scores of the sample contractors and the amount of top prime contracts awarded was -0.29. This resulted in a random variable t = -1.13. Therefore the null hypothesis (H_0) cannot be rejected for the upper one-sided test. When the sum of the procurement and RDT&E accounts was correlated with the Dagel and Pepper Z-scores, the sample correlation factor (r) of -0.687 was found. These correlation results are opposite of what was expected since they state that as defense spending increased, the financial health of the contractors decreased.

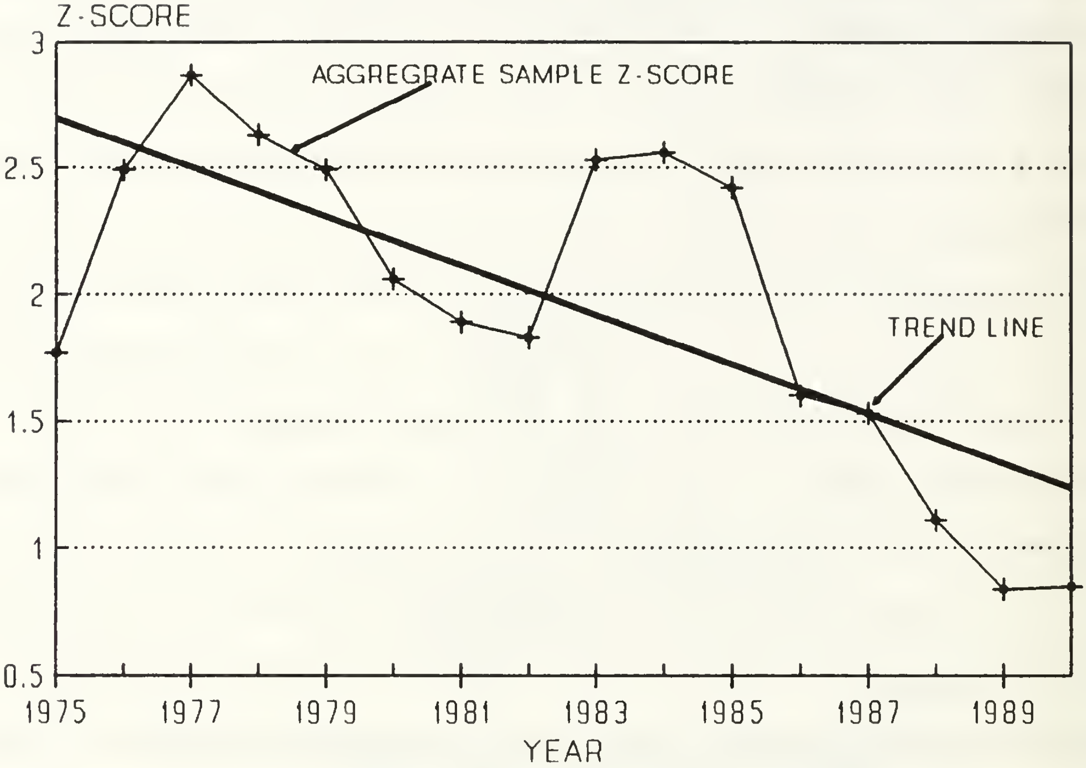

Figure 10. Dagel and Pepper Aggregate Z-Scores

A plot of the aggregate Z-scores versus time is shown in Figure 10. This figure shows that although there are peaks over the years, the general trend is downward.[18] Attempting to explain this overall trend, the general decline in the financial health of the contractors could be attributed to a number of items such as the shift to more fixed-price contracts by DoD in the 1980's or increased competition among the contractors themselves in the face of declining defense dollars in the late 1980's.

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[18] This trend is consistent with the findings of the Treglia study (1991) from 1984 to 1989.

The problem posed by this declining financial health trend had to be confronted. A statistical technique for removing the general trend from the data was needed. It was decided that the general trend could be removed by adding a variable reflecting time to the analysis. The technique used was to add the year as an independent variable in a multiple regression equation, effectively controlling for the time trend.

C. DESCRIPTIVE INFORMATION

Table 3 shows the descriptive statistics developed for the dependent, independent, and control variables. The dependent variables are the Z-scores calculated from the Dagel and Pepper model and cover the entire sixteen-year period. All dollar amounts for independent and control variables are stated in terms of constant 1982 dollars.

A percent of DoD business greater than 100 percent resulted for three contractors during certain years. This was due to the contractor receiving more DoD contracts than their total revenue for that year. Causes of this situation can be attributed to timing differences and the multi-year contract awards which were addressed in Chapter III Section H. Over the entire period, this is smoothed by the use of averaged data. Three companies have lower percentages of DoD business than were expected based on comparisons with the reported percent of government sales as stated by the RRG Associates

TABLE 3

STATISTICAL DATA DESCRIPTION

DEPENDENT (Z-SCORE)	**MEAN**	**STD DEV**	**MINIMUM**	**MAXIMUM**
Aggregate	1.967	0.649	0.844	2.871
Boeing	3.088	1.744	-0.842	5.075
General Dynamics	1.186	1.403	-1.585	3.192
General Electric	2.791	0.625	1.737	3.397
General Motors	3.014	1.560	0.012	5.167
Grumman	0.610	1.356	-2.394	2.784
Honeywell	2.253	0.479	1.052	2.782
IBM	4.303	1.850	2.011	7.471
Litton	1.770	1.272	0.444	3.725
Lockheed	2.143	1.604	0.071	5.373
LTV	-2.726	3.734	-9.537	0.819
Martin Marietta	1.769	1.360	-1.473	3.408
McDonnell Douglas	0.783	1.125	-1.282	2.641
Northrop	3.631	0.938	2.184	5.103
Raytheon	3.819	0.739	2.281	4.863
Rockwell Inter	3.122	0.833	1.079	4.527
Textron	0.646	0.973	-1.216	1.993
United Tech	1.218	0.661	-0.018	2.865
Westinghouse	1.986	0.478	0.706	2.524
INDEPENDENT				
DOD PRI CON 82$	105.86	21.06	72.00	137.10
PRO+RDT 82$	70.65	23.35	44.10	101.80
DELTA DOD PC (%)	2.89	6.98	-8.5	12.7
DELTA PRO+RDT (%)	4.62	6.82	-6.2	16.6

TABLE 3 (CONTINUED)

STATISTICAL DATA DESCRIPTION

CONTROL	MEAN	STD DEV	MINIMUM	MAXIMUM
GNP 82$	3415.	455.	2695.	4157.
DELTA GNP (%)	2.70	2.48	-2.5	6.8
CAP UTIL (%)	77.60	5.34	63.9	85.4
%DOD BUSINESS				
Aggregate	34.01	4.90	28.12	41.59
Boeing	28.88	10.54	8.21	44.08
General Dynamics	78.06	19.75	47.27	129.59
General Electric	13.27	4.35	8.58	22.34
General Motors	1.88	1.43	0.66	4.93
Grumman	86.45	12.39	65.38	103.49
Honeywell	21.10	7.54	12.72	38.21
IBM	2.61	0.71	1.57	3.56
Litton	33.58	11.67	15.36	52.99
Lockheed	49.93	10.27	33.91	63.89
LTV	13.32	7.25	5.60	29.33
Martin Marietta	47.12	16.89	20.50	72.04
McDonnell Douglas	63.31	11.22	42.94	79.53
Northrop	39.81	29.98	9.19	117.01
Raytheon	41.69	7.81	30.31	55.44
Rockwell Inter	27.97	17.98	11.07	66.72
Textron	24.08	9.54	14.05	47.53
United Tech	25.35	6.52	13.32	38.30
Westinghouse	13.84	4.55	5.36	19.40

reference. The companies were Northrop, Lockheed, and Martin Marietta. There is no known reason for the disparity.

D. CORRELATION ANALYSIS

This section describes the correlation analysis between the dependent, independent, and control variables. This analysis was required to eliminate some of the independent and control variables from the model to prevent multicollinearity. This step was required prior to the regression model development because as Newbold states:

> The art of model building is to recognize the impossibility of accounting for the myriad individual influences on a variable of interest and to try, rather, to pick out the most influential factors. Next it is necessary to formulate a model to depict the interaction of these factors. The goal is to achieve a model that is sufficiently simple to allow convenient interpretation but not so oversimplified that important influences are ignored. (Newbold, 1988, p. 544)

Table 4 shows the results of the correlation analysis. The correlation values shown are from the Pearson product moment correlation coefficient. The Spearman rank correlation of the data was also conducted with very similar results.

1. Analysis Between Dependent and Independent Variables

The correlation data between the aggregate financial health of the contractors (AGGRE DPZ) and the independent and control variables show interesting results. There is a high negative correlation between the aggregate Z-score (AGGRE DPZ) and the year (YEAR). This was expected because of the falling trend shown in Figure 10. The correlation between the

TABLE 4

CORRELATION DATA

	AGGRE DPZ	YEAR	DOD PRI CON
INDEPENDENT			
YEAR	-0.714		
DOD PRI CON	-0.290	0.785	
PRO+RDT	-0.687	0.960	0.799
DELTA DOD PC	0.588	-0.514	-0.149
DELTA PRO+RDT	0.317	0.214	0.241
CONTROL			
GNP	-0.731	0.979	0.686
DELTA GNP	0.388	0.068	0.113
CAP UTIL	-0.026	0.046	-0.310
AGGREG %DOD	0.388	0.106	0.623
	PRO+RDT	DELTA DOD PC	DELTA PRO+RDT
DELTA DOD PC	-0.597		
DELTA PRO+RDT	0.174	0.241	
GNP	0.941	-0.573	0.098
DELTA GNP	0.121	-0.180	0.033
CAP UTIL	0.042	-0.325	-0.361
AGGREG %DOD	0.200	0.288	0.664
	GNP	DELTA GNP	CAP UTIL
DELTA GNP	0.140		
CAP UTIL	0.242	0.560	
AGGREG %DOD	-0.028	0.228	-0.472

defense spending variables (DOD PRI CON and PRO+RDT) was discussed in Section B of this chapter. Since both defense spending variables and the year have negative correlations with the aggregate Z-score, inclusion of the year variable in the regression model may allow the trend to be "washed away".

The correlations between variables reflecting the change in the defense spending variables (DELTA DOD PC and DELTA PRO+RDT) and the aggregate Z-score are positive, which was expected. As defense spending changed, it was expected that contractors would obtain a share of the increased or decreased defense contract dollars; hence their financial condition would be expected to improve with increases in defense spending and deteriorate with decreases.

The GNP (GNP) shows a high negative correlation with the aggregate Z-score while the change in GNP variable (DELTA GNP) shows a positive correlation with the aggregate Z-score. A positive correlation was expected since an increase in GNP is expected to improve the financial condition of the contractors.

The capacity utilization variable (CAP UTIL) has a low negative correlation with the aggregate Z-score. This was unexpected since the results of Greer and Liao (1986) showed a high positive correlation between the capacity utilization and contractor profitability. In a competitive market situation, contractors can normally demand and receive higher prices for their goods as capacity utilization increases.

The aggregate percent DoD business (AGGREG %DOD) shows a low positive correlation with the aggregate Z-score. This indicates that as the percent of DoD business increased, financial condition improved. This result is consistent with the 1986 GAO report findings and the Morse and Kramer thesis (1985), but it is inconsistent with the Treglia study (1991). Since the correlation found in this study is only 0.388, it does not provide a strong enough case that a positive relationship exists for any definitive conclusion to be drawn.

2. Analysis Between Independent Variables

The correlations among the independent and control variables were used for selecting which variables to use in the regression model. An extremely high correlation between two (or more) independent variables in a regression model can result in the regression coefficients being unreliable.

The defense spending variables (DOD PRI CON and PRO+RDT) are highly correlated with the year (YEAR) and GNP (GNP) variables. Also, GNP is highly correlated with the year. A problem with multicollinearity could exist if all these variables were used in the same regression model. To limit the effects of multicollinearity, the change in GNP (DELTA GNP) was selected over GNP (GNP) for use in the regression model as the control variable representing for "other" economic influences. The high correlation between the year (YEAR) and defense spending variables (DOD PRI CON and

PRO+RDT) still exists and will influence the regression model. The impact this has on the model can be assessed by using the significance of individual variables in the regression analysis.[19]

Capacity utilization (CAP UTIL) was not selected for the regression model so as to limit the number of variables in the model. There is a positive relationship between capacity utilization and the change in GNP (DELTA GNP). This was expected since capacity utilization is higher during periods of higher GNP. The change in GNP variable accounts for some of the effects of the capacity utilization.

The aggregate percent of DoD business variable (AGGREG %DOD) has strong positive correlations with the aggregate DoD prime contracts variable (DOD PRI CON) and the change in procurement and RDT&E variable (DELTA PRO+RDT). This was expected since an increase in DoD spending is expected to increase the percent of DoD business for the contractors. To minimize the multicollinearity and the number of variables, the aggregate percent DoD business was not selected for the regression model. Percent of DoD business for each individual contractor was used instead in the analysis after the regression model was developed.

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[19] "A clear indication of the likely presence of multicollinearity occurs when, taken as a group, a set of independent variables appears to exert considerable influence on the dependent variable, but when looked at separately, through tests of hypotheses, all appear individually to be insignificant." (Newbold, 1988, pp. 570-571)

Two sets of four variables were chosen for the regression model as a result of this correlation analysis. The first set includes the year (YEAR), the aggregate DoD prime contracts (DOD PRI CON), the change in the aggregate DoD prime contracts (DELTA DOD PC), and the change in GNP (DELTA GNP). The second set includes the year (YEAR), the procurement and RDT&E outlays (PRO+RDT), the change in the procurement and RDT&E outlays (DELTA PRO+RDT), and the change in GNP (DELTA GNP). The only concern of possible multicollinearity with these two sets is between the year and the defense spending variables (DOD PRI CON and PRO+RDT). By checking the individual variable significance in the regression equation, the existence of multicollinearity can be surmised.

E. MODEL DEVELOPMENT

The correlation data and analysis from the previous section were used in selecting the best measures to incorporate in the regression models. This section details the models that resulted.

Four variables were chosen to develop the regression model. First, the year variable was selected to remove the negative trend in the financial condition of the contractors. The second and third variables were selected together as a pair. Analysis were performed with two pairs, which were DoD prime contract awards coupled with the change in DoD prime contract awards and the sum of procurement and RDT&E outlays coupled with its change variable. The final variable chosen was the change in GNP to control for all the "other" economic factors that affected the financial health of the contractors. The results of the multiple regressions using the Z-score as the dependent variable are listed in Table 5.

TABLE 5

REGRESSION MODELS

	Using the prime contract awards and its yearly change, the coefficients are:				
	Intercept	YEAR	DOD PRI CON	DELTA DOD PC	DELTA GNP
	277	-0.139	0.0153	0.0201	0.115
STD DEV	59.14	0.030	0.006	0.013	0.028
SIGNI (p)	0.000	0.000	0.025	0.151	0.002
	F=21.18 p=0.000 R^2=88.5% ADJ R^2=84.3% DW=1.92 d_L=0.53 d_U=1.66 at 1%				
	Using the Procurement and RDT&E outlays and its change, the coefficients are:				
	Intercept	YEAR	PRO+RDT	DELTA PRO+RDT	DELTA GNP
	195	-0.097	-0.004	0.044	0.115
STD DEV	80.06	0.040	0.008	0.008	0.022
SIGNI (p)	0.033	0.036	0.651	0.000	0.000
	F=35.11 p=0.000 R^2=92.7% ADJ R^2=90.1% DW=2.70 d_L=0.53 d_U=1.66 at 1%				

Table 5 shows that the signs of the variable coefficients are as expected in the regression using the prime contract award measures as the independent variable. The coefficient for year (YEAR) is negative; for prime contract awards (DOD PRI CON), the coefficient is positive; for the change in prime contract awards (DELTA DOD PC), the coefficient is positive, and for the change in GNP (DELTA GNP), the coefficient is positive. The Durbin-Watson statistic shows no autocorrelation in the errors at a test of one percent significance.[20] All the variable coefficients are significant (SIGNI) at 0.151 or better which leads to the conclusion that multicollinearity is not a major factor in this model.

The regression data in Table 5 using the procurement and RDT&E outlays (PRO+RDT) as the independent variable shows that the sign of the procurement and RDT&E outlays is negative, which had not been expected. All other coefficient signs are as expected. The Durbin-Watson statistic again shows no autocorrelation in the errors at one percent significance. The significance of the procurement and RDT&E outlays variable (PRO+RDT) is low at 0.651, which indicates possible multicollinearity in this model.

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[20] In the least squares regression model, it is assumed that the error terms are not correlated with one another. It is important when using time series data regressions to test if the error terms are correlated. If the error terms are correlated, the problem is called autocorrelated errors. To test for autocorrelation, the Durbin-Watson test is performed. Basically, if the calculated Durbin-Watson statistic (d) is greater than the tabulated value of d_U, the hypothesis that no autocorrelation in the errors is accepted. (Newbold, 1988, pp. 581-588)

These results lead to more confidence being placed in the model developed from the prime contract awards. This model allowed the year variable to wash out the negative trend. This model was chosen for further analysis examining relationships between the financial condition of the individual contractors and defense spending.

F. CONTRACTOR HEALTH AND FIRM-SPECIFIC DEFENSE SPENDING

The final analysis performed was to relate the financial condition of the individual contractors with the amount of firm-specific defense spending. This analysis was conducted by constructing regression models for each firm both with and without using the year variable (YEAR) to remove the general trend. The use of the year variable was justified in the aggregate case. However, when considering the contractors on an individual level, a general trend may not be apparent since each contractor is diversified and makes independent business decisions.

Tables 6 and 7 show the results of the regression analysis. The individual contractor Z-score (dependent) was regressed on five variables other than the year. These other variables included: 1) the yearly prime contracts (constant dollars) awarded by DoD to the contractor (PC), to reflect the direct impact of DoD spending on the contractor; 2) the change in prime contracts awarded by DoD to the contractor (DELTA PC), to reflect the impact of the change of DoD contracts on

TABLE 6

INDIVIDUAL CONTRACTOR REGRESSION COEFFICIENTS (WITHOUT TREND REMOVAL)

NAME	INTER	PC	DELTA PC	DOD PRI CON	DELTA DOD PC	DELTA GNP	ADJ R^2 %	%DOD
BOE	6.210	-0.744	-0.00385	-0.01520	-0.0278	0.3072	22.7	29
p	0.018	0.501	0.906	0.707	0.704	0.136		
GD	2.110	0.767	-0.01990	-0.05280	0.1996	0.1521	14.2	78
p	0.339	0.312	0.192	0.314	0.034	0.366		
GE	2.260	-0.858	0.02790	0.03640	-0.0229	-0.0028	88.1	13
p	0.000	0.000	0.001	0.000	0.189	0.907		
GM	6.420	-0.944	0.01231	-0.02610	-0.0313	0.2850	82.6	2
p	0.000	0.003	0.007	0.034	0.438	0.002		
GRU	-0.079	0.791	0.00430	-0.01950	0.0345	0.3365	13.2	86
p	0.976	0.673	0.863	0.435	0.595	0.063		
HON	3.090	-0.042	0.01070	-0.00900	0.0018	0.0373	5.3	21
p	0.004	0.968	0.260	0.601	0.944	0.473		
IBM	13.000	3.509	-0.01410	-0.11940	0.1249	0.0510	68.0	3
p	0.000	0.186	0.289	0.017	0.018	0.670		
LIT	0.595	0.119	-0.00330	0.00814	0.0997	-0.0516	0.0	34
p	0.807	0.922	0.760	0.634	0.117	0.749		
LOC	-5.780	0.883	-0.02590	0.03950	0.0541	0.2181	84.7	50
p	0.000	0.037	0.087	0.007	0.110	0.013		
LTV	6.370	4.516	-0.00480	-0.13130	0.3768	-0.0504	62.4	13
p	0.110	0.204	0.792	0.025	0.002	0.856		

TABLE 6 (CONTINUED)

INDIVIDUAL CONTRACTOR REGRESSION COEFFICIENTS (WITHOUT TREND REMOVAL)

NAME	INTER	PC	DELTA PC	DOD PRI CON	DELTA DOD PC	DELTA GNP	ADJ R^2 %	%DOD
MAM	3.090	0.390	0.00790	-0.02360	-0.0469	0.1822	0.0	47
p	0.337	0.737	0.798	0.621	0.722	0.317		
MCD	-3.850	-0.711	0.00860	0.07370	0.0351	0.2344	66.5	63
p	0.002	0.016	0.401	0.002	0.239	0.011		
NOR	-1.040	1.565	-0.00740	0.02440	0.0318	0.1528	54.2	40
p	0.548	0.060	0.252	0.060	0.316	0.122		
RAY	2.090	-1.733	0.02790	0.05500	-0.0415	0.0538	71.3	42
p	0.004	0.000	0.006	0.000	0.126	0.239		
ROC	-0.480	-0.070	0.00850	0.03120	0.0203	0.1281	70.9	28
p	0.543	0.572	0.028	0.004	0.296	0.049		
TEX	3.880	-1.230	0.00090	-0.02330	0.0220	0.1396	78.3	24
p	0.000	0.036	0.867	0.005	0.490	0.018		
UT	2.390	-0.733	-0.00460	0.00720	0.0723	0.0792	31.3	25
p	0.032	0.068	0.703	0.437	0.030	0.251		
WES	0.230	-0.838	0.00240	0.02520	0.0101	0.0684	16.4	14
p	0.760	0.312	0.715	0.114	0.574	0.178		
COR1		-0.070	-0.203	0.270	0.008	0.473		
COR2		-0.189 (9)	-0.676 (6)	0.686 (11)	-0.050 (8)	0.440 (9)		

TABLE 7

INDIVIDUAL CONTRACTOR REGRESSION COEFFICIENTS (WITH TREND REMOVAL)

NAME	INTER	YEAR	PC	DELTA PC	DOD PRI CON	DELTA DOD PC	DELTA GNP	ADJ R^2 %	%DOD
BOE	-393	0.2035	0.1400	-0.01520	-0.0776	0.0138	0.2878	18.5	29
p	0.511	0.505	0.935	0.687	0.451	0.887	0.177		
GD	804	-0.4081	0.6197	-0.01430	0.0242	0.0597	0.0510	71.2	78
p	0.000	0.000	0.173	0.120	0.487	0.315	0.607		
GE	8.53	-0.0032	-0.8498	0.02770	0.0366	-0.0229	-0.0031	86.8	13
p	0.890	0.919	0.000	0.004	0.002	0.213	0.904		
GM	529	-0.2656	-0.4070	0.00480	0.0091	-0.0438	0.2592	91.0	2
p	0.010	0.011	0.123	0.206	0.512	0.153	0.000		
GRU	437	-0.2220	0.8550	-0.00140	0.0163	-0.0246	0.2780	24.0	86
p	0.154	0.154	0.628	0.952	0.624	0.733	0.106		
HON	-250	0.1285	-0.4483	0.01710	-0.0243	0.0227	0.0546	47.7	21
p	0.015	0.015	0.573	0.037	0.104	0.206	0.181		
IBM	645	-0.3219	2.0520	-0.00760	-0.0427	0.0238	0.0156	87.7	3
p	0.002	0.003	0.224	0.367	0.212	0.533	0.835		
LIT	409	-0.2070	-0.6830	0.00255	0.0436	0.0227	-0.0538	0.0	34
p	0.268	0.269	0.624	0.827	0.234	0.799	0.735		
LOC	-282	0.1401	1.3340	-0.03530	0.0058	0.1069	0.2146	86.6	50
p	0.149	0.157	0.016	0.034	0.817	0.041	0.012		
LTV	1265	-0.6412	1.0650	0.00410	0.0173	0.1759	-0.0366	77.7	13
p	0.020	0.021	0.717	0.775	0.798	0.112	0.865		

TABLE 7 (CONTINUED)

INDIVIDUAL CONTRACTOR REGRESSION COEFFICIENTS (WITH TREND REMOVAL)

NAME	INTER	YEAR	PC	DELTA PC	DOD PRI CON	DELTA DOD PC	DELTA GNP	ADJ R^2 %	%DOD
MAM	-880	0.4468	-1.8760	0.02040	-0.0110	-0.0729	0.2007	0.0	47
p	0.149	0.148	0.318	0.502	0.808	0.560	0.246		
MCD	295	-0.1516	-0.3154	0.00050	0.07370	0.0135	0.1895	67.6	63
p	0.283	0.278	0.472	0.968	0.002	0.696	0.049		
NOR	180	-0.0917	1.1740	-0.00540	0.0349	0.0141	0.1571	55.1	40
p	0.304	0.302	0.183	0.410	0.044	0.686	0.114		
RAY	293	-0.1476	-0.6987	0.01790	0.0504	-0.0291	0.0390	75.4	42
p	0.135	0.137	0.358	0.097	0.000	0.260	0.364		
ROC	99	-0.0506	-0.1299	0.00890	0.0427	0.0074	0.1327	69.8	28
p	0.448	0.446	0.387	0.028	0.031	0.771	0.049		
TEX	90	-0.0438	-1.2600	0.00110	-0.0159	0.0082	0.1319	77.5	24
p	0.420	0.440	0.038	0.839	0.190	0.822	0.020		
UT	-113	0.0584	-0.6371	-0.00670	-0.0041	0.0878	0.0975	29.4	25
p	0.424	0.415	0.128	0.598	0.804	0.030	0.193		
WES	210	-0.1066	0.2316	-0.00200	0.0248	-0.0148	0.0384	28.1	14
p	0.139	0.139	0.819	0.763	0.098	0.523	0.440		
COR1		0.041	0.062	0.262	0.315	-0.052	0.358		
COR2		0.143 (10)	0.665 (7)	-0.718 (6)	0.631 (8)	0.420 (4)	0.341 (10)		

the contractor; 3) the constant dollar total prime contracts awarded by DoD to all contractors (DOD PRI CON), to reflect the impact of DoD spending on the defense industry as a whole; 4) the change in total prime contracts awarded by DoD to all contractors (DELTA DOD PC), to reflect the impact of the change in DoD spending on the defense industry as a whole; and 5) the change in GNP (DELTA GNP), to account for all the outside economic factors. The coefficients for each variable and the significance (p) of the variable is listed.

The tables contain 36 regression models, two for each of the 18 firms. Thus they contain 36 separate tests of the influence of each variable on financial health. In evaluating the influence of individual variables, two things are important to observe: the signs of the coefficients and their significance. A liberal p = 0.20 level of significance was adopted as threshold. Several observations are worth noting.

For firm-specific prime contracts (PC) and the change in firm-specific prime contracts (DELTA PC), most coefficients are insignificant. When significant, positive signs (n = 14) and negative signs (n = 14) are equally common. Thus there is no indication of a relationship between financial health and firm-specific defense spending.

For aggregate DoD prime contracts (DOD PRI CON) and the change in aggregate DoD prime contracts (DELTA DOD PC), a larger number of coefficients are significant; and positive significant coefficients (n = 23) outnumber negative ones (n

= 8) about three to one. This provides some weak indication that firm-specific financial health is related to aggregate DoD spending as hypothesized.

Most interestingly, the majority of coefficients (n = 19) for the change in GNP (DELTA GNP) are positive and significant (and there are no significant negative coefficients). Thus the strongest evidence is consistent with economy wide economic conditions influencing financial health more consistently than DoD spending variables.

The regression models also give indications of the collective ability of the variables to explain financial health at the firm level. Tables 6 and 7 show the regression equation adjusted R^2 values. The adjusted R^2 values provide an indication as to how well the regression models were able to account for the change in the dependent variables of financial condition. The adjusted R^2 data also shows that the financial health of several contractors is poorly explained by the regression performed. A possible reason for this could be that the financial condition of these contractors is more dependent on how the company is operated and the types of management decisions that are made. In short, there are other factors not included in the models that dominate the factors that are included.

It was hypothesized that the greater the percent of DoD business, the more sensitive the contractor would be to defense spending. This greater sensitivity should be reflected by a higher beta. To test this, the percent of DoD business was correlated with the beta coefficients from the regression. The percent of DoD business for the individual contractors was determined by averaging the yearly values for each contractor over the sixteen years. The correlation was run twice for each variable. The first run (COR1) included the beta coefficients for all eighteen companies, the full sample. Prior to the second run (COR2), variables with significance lower than 0.200 were eliminated from the data set, creating a reduced data set. This second correlation was performed to determine if the companies whose performance was not explained by the model affected the results of the first run. The number under the COR2 value is the number of observations that were used in the second reduced sample set. The lower the absolute value of the correlation, the less significant is the correlation result.

Several patterns are worth noting. First, most of the correlations in the full sample (COR1) test are small. This suggests that relying on the reduced sample test may provide better insights. But in fact, the sample size in the COR2 tests is quite small, so the results are tentative at best.

Second, there is a high negative correlation between the change in prime contracts for the individual contractor (DELTA PC) and the percent of DoD business for the contractor (%DOD) in both tables. This is surprising. The hypothesis was that greater percentage of DoD business would be associated with greater positive association between firm-specific DoD spending and financial health.

Third, there does seem to be the expected positive relationship between the sensitivity of firm financial condition to aggregate DoD spending (DOD PRI CON) and the percentage of DoD business (%DOD).

Fourth, the positive correlation between percent DoD business (%DOD) and the change in GNP (DELTA GNP) is not as one might hypothesize. As percent of DoD business increases, one might expect less sensitivity of financial health to general economic conditions (a negative correlation), not more.

The correlation analysis between the coefficients and percent of DoD business does not lead to any convincing conclusions. Although some of the correlation values increased once the less significant coefficients were removed, the remaining number of observations was too small to draw any general conclusions for the population.

V. SUMMARY AND CONCLUSIONS

This study started by attempting to relate the overall financial condition of defense contractors with the amount of dollars the government spends on defense. A seven step process to analyze this relationship was developed. The process began with a detailed literature review and was followed by a statement of the research hypothesis. Next, a sample of eighteen defense contractors was selected. The dependent, independent, and control variables were then developed. After collecting the required data, relationships between contractor financial condition and defense spending was analyzed and tests were structured to examine hypothesized associations. Finally, the financial condition of the selected contractors was analyzed to detect any significant relationships with the defense spending measures.

The findings of this study include:

1. The selected defense contractors have experienced a decreasing trend in their financial health over the past sixteen years. Whether this decreasing financial health trend is due solely to their defense-related business is doubtful. In the last two years of the study, some of the decreasing trend can be attributed to the overall declining economy.
2. After removing the declining financial condition trend, a positive relationship exists between the amount of DoD contracts awarded and the financial condition of the group of defense contractors in the aggregate.

3. There appears to be no consistent relationship between the financial condition of the individual contractors and the amount of DoD prime contracts awarded.

4. The amount of DoD business has a positive association with financial health at the level of the aggregate defense industry. However, at the individual contractor level, no conclusion can be drawn as small sample size prohibited significant conclusions.

The conclusions that can be drawn from these findings are that as the amount of DoD contract awards decreases, the financial condition of the defense industry as a whole will probably continue to decline. Which contractors individually will do worse and which will perform better financially is not predictable on the basis of the amount of DoD spending. The financial condition of the defense contractors will probably depend less on the amount of DoD prime contracts or defense spending, and depend more on how management responds to the changing environment.

APPENDIX I

This appendix lists the terms used in the equations for the Dagel and Pepper Z-score model and the Zavgren logit model, which used the COMPUSTAT data. The definitions, as they were described by the respective model, are stated along with what was used in this study to approximate their data. The terms in the "THIS STUDY" column can be referenced to Table 2 in relation to how they were determined from the balance and income statements.

TERM	REFERENCE DEFINITION	THIS STUDY
Cash	COMPUSTAT - This item represents any immediately negotiable medium of exchange. It includes money and any instruments normally accepted by banks for deposit and immediate credit to a customer's account. Includes: Cash, Checks, Demand deposits,... Excludes: Commercial paper, Gvt securities, Time deposits ...	Cash + Marketable Securities
Cash Flow	Dagel and Pepper - net income before depreciation, depletion, and amortization.	Net income + depreciation
Current Assets	Dagel and Pepper - cash and those assets which in the normal course of business will be turned into cash within a year from the date of the balance sheet.	Total current assets
Current Liabilities	Dagel and Pepper - all debts that fall due within the coming year.	Current Liabilities

Current Liabilities	COMPUSTAT - this item represents the total amount of short-term notes and the current portion of long-term debt (debt due in one year).	Current Liabilities
Inventory	COMPUSTAT - five types of inventory are listed in this reference. This definition is for total inventory - this item represents merchandise bought for resale and materials and supplies purchased for use in production of revenue. Lists items included and excluded.	Inventory
Long-term Debt (Debt in Zavgren model)	COMPUSTAT - this item represents debt obligations due more than one year from the company's balance sheet date. Lists items included and excluded.	Total noncurrent liabilities
Net Plant	COMPUSTAT - has ten choices of which two of the most probable used in the Zavgren study are property, plant, and equipment - total (net) or total (net) (restated).	Net plant, property, and equipment
Net Sales	Dagel and Pepper - the amount received after taking into consideration returned goods and allowances for reduction of prices.	Net sales
Quick Assets	Dagel and Pepper - the sum of cash, marketable securities, and receivables.	Cash + marketable securities + receivables

Quick Assets	COMPUSTAT - has no specific definition for quick assets, but it can be calculated a number of ways. Pinches, et al., (1973) - quick assets = cash + receivables Zavgren - unclear what she used. She states in verbiage that "if [one] substitutes the current ratio with the acid test ratio, one can ignore inventory" (Zavgren, 1985, p. 24).	Total current assets - inventory
Receivables	COMPUSTAT - has four different types. For total - this item represents claims against others (after applicable reserves) collectible in money, generally within one year. Lists items included and excluded.	Receivables
Sales	COMPUSTAT - has two, net and restated. For net - this item represents gross sales (the amount of actual billings to customers for regular sales completed during the period) reduced by cash discounts, trade discounts, and returned sales and allowances for which credit is given to customers. List items included and excluded.	Net Sales
Total Assets	Dagel and Pepper - the sum of current and fixed assets	Total assets

Total Assets	COMPUSTAT - this item represents current assets plus net plant plus other non-current assets (including intangible assets, deferred items, and investments and advances). Also has a restated total assets.	Total assets
Total Capital	COMPUSTAT - has four different definitions for total invested capital. Used definition 1 where it equals long-term debt + carrying of value preferred stock + total common stock + minority interest. Pinches, et al., (1973) then stated total capital = invested capital - long-term debt.	Total equity + minority interest
Total Debt	Dagel and Pepper - total liabilities (excluding stockholders' equity) plus preferred stock.	Total liabilities + preferred stock
Total Income	COMPUSTAT - from Pinches, et al., (1973) total income = net income + non-recurring income/expenses. COMPUSTAT defines non-operating income/expenses to represent any income or expense items resulting from secondary business-related activities, excluding those considered part of the normal operations of the business. Lists items included and excluded.	Net income + other income (net)

Working Capital	Dagel and Pepper - the difference between current assets and current liabilities.	Total current assets - current liabilities

APPENDIX II

This appendix lists the three calculated measures for each contractor used in the sample. In the first column is the percent of DoD business for the contractor (CONTRACTOR ABBREVIATION %DOD) determined from prime contracts awarded/total revenue. Contractor abbreviations are listed in Table 1. The second column lists the Dagel and Pepper Z-score which was calculated for each contractor (CONTRACTOR DPZ) for the given year. The third column lists the Zavgren financial health measure (CONTRACTOR ZAV) which was calculated for each contractor for the given year. The fourth column lists the 1982 constant dollar amount of prime contracts awarded to the contractor (CONTRACTOR PC82). The last column lists the change in prime contract awards for the contractor (CONTRACTOR DELPC).

After the contractor data, other variables used for the analysis are listed.

	BOE%DOD	BOEDPZ	BOEZAV	BOEPC82	BOEDELPC
1975	42.0%	2.488	0.5124	2,885.08	30.3%
1976	30.0%	4.508	0.5396	2,017.75	-30.1%
1977	39.3%	4.947	0.5460	2,507.75	24.3%
1978	27.9%	5.075	0.5512	2,261.80	-9.8%
1979	18.6%	5.067	0.5492	2,071.82	-8.4%
1980	25.3%	3.106	0.5404	2,919.78	40.9%
1981	27.4%	0.856	0.5328	2,919.19	0.0%
1982	35.8%	-0.842	0.5131	3,238.80	10.9%
1983	39.7%	0.836	0.5344	4,240.41	30.9%
1984	44.1%	1.601	0.5335	4,241.46	0.0%
1985	40.0%	3.640	0.5396	4,966.70	17.1%
1986	24.9%	3.792	0.5425	3,634.76	-26.8%
1987	24.1%	3.035	0.5375	3,322.94	-8.6%
1988	19.0%	3.613	0.5385	2,812.16	-15.4%
1989	15.5%	2.840	0.5226	2,658.08	-5.5%
1990	8.2%	4.847	0.5305	1,870.15	-29.6%

	GD%DOD	GDDPZ	GDZAV	GDPC82	GDDELPC
1975	59.7%	1.716	0.5012	2,382.17	-37.5%
1976	56.6%	1.306	0.4999	1,840.44	-22.7%
1977	47.3%	1.445	0.5044	2,176.99	18.3%
1978	129.6%	1.219	0.5052	6,162.53	183.1%
1979	86.0%	2.433	0.4999	4,777.21	-22.5%
1980	74.2%	1.769	0.4862	4,305.88	-9.9%
1981	67.2%	2.052	0.4775	3,702.37	-14.0%
1982	95.7%	2.591	0.5109	5,891.10	59.1%
1983	95.4%	3.192	0.5193	6,537.21	11.0%
1984	75.9%	2.698	0.5249	5,531.17	-15.4%
1985	91.1%	0.920	0.4732	6,769.71	22.4%
1986	90.1%	0.613	0.5145	7,154.44	5.7%
1987	75.4%	0.626	0.5155	6,264.20	-12.4%
1988	68.3%	-0.693	0.5173	5,676.35	-9.4%
1989	71.8%	-1.326	0.4669	6,094.01	7.4%
1990	64.7%	-1.585	0.5046	5,432.21	-10.9%

	GE%DOD	GEDPZ	GEZAV	GEPC82	GEDELPC
1975	9.0%	2.647	0.5255	2,336.75	-6.3%
1976	8.6%	2.869	0.5344	2,310.33	-1.1%
1977	8.7%	3.008	0.5378	2,412.11	4.4%
1978	9.1%	3.151	0.5365	2,650.52	9.9%
1979	9.1%	3.317	0.5353	2,794.08	5.4%
1980	8.8%	3.277	0.5310	2,695.28	-3.5%
1981	11.1%	3.282	0.5314	3,284.03	21.8%
1982	13.8%	3.397	0.5313	3,654.10	11.3%
1983	16.9%	3.397	0.5288	4,331.75	18.5%
1984	16.2%	3.300	0.5260	4,195.60	-3.1%
1985	22.3%	3.279	0.5253	5,748.94	37.0%
1986	20.2%	2.033	0.5212	6,342.16	10.3%
1987	15.3%	1.737	0.5262	5,355.24	-15.6%
1988	15.4%	1.816	0.5176	5,193.20	-3.0%
1989	14.7%	2.022	0.5143	5,096.93	-1.9%
1990	13.4%	2.119	0.5080	4,742.78	-6.9%

	GM%DOD	GMDPZ	GMZAV	GMPC82	GMDELPC
1975	1.1%	3.852	0.5281	721.60	17.0%
1976	0.7%	5.035	0.5305	592.07	-17.9%
1977	0.7%	4.978	0.5234	603.35	1.9%
1978	0.7%	5.167	0.5259	622.45	3.2%
1979	0.7%	4.828	0.5196	614.40	-1.3%
1980	0.9%	2.998	0.5213	622.77	1.4%
1981	1.0%	2.170	0.5121	676.41	8.6%
1982	1.1%	1.994	0.5268	689.52	1.9%
1983	1.2%	3.661	0.5359	856.61	24.2%
1984	1.2%	3.835	0.5385	946.74	10.5%
1985	1.7%	3.051	0.5257	1,468.76	55.1%
1986	4.9%	2.323	0.5226	4,526.16	208.2%
1987	4.0%	1.563	0.5240	3,631.43	-19.8%
1988	3.2%	1.632	0.5298	3,089.80	-14.9%
1989	3.3%	1.125	0.5307	3,120.46	1.0%
1990	3.7%	0.012	0.5266	3,388.26	8.6%

	GRU%DOD	GRUDPZ	GRUZAV	GRUPC82	GRUDELPC
1975	101.1%	0.483	0.5287	2,483.06	75.7%
1976	65.4%	1.872	0.5231	1,684.44	-32.2%
1977	92.0%	2.784	0.5214	2,266.76	34.6%
1978	81.1%	1.890	0.5241	1,750.79	-22.8%
1979	92.4%	1.137	0.5220	1,866.15	6.6%
1980	76.4%	-0.634	0.5239	1,618.14	-13.3%
1981	89.3%	-2.393	0.5258	1,861.12	15.0%
1982	94.9%	-0.280	0.5252	1,900.49	2.1%
1983	103.5%	1.451	0.5225	2,202.97	15.9%
1984	94.6%	1.681	0.5422	2,248.18	2.1%
1985	89.6%	1.720	0.5226	2,486.68	10.6%
1986	86.3%	1.511	0.5244	2,649.55	6.5%
1987	102.0%	-0.102	0.5255	3,018.43	13.9%
1988	79.3%	-0.170	0.5049	2,478.43	-17.9%
1989	67.7%	-0.718	0.5082	2,006.03	-19.1%
1990	67.6%	-0.477	0.5111	2,225.22	10.9%

	HON%DOD	HONDPZ	HONZAV	HONPC82	HONDELPC
1975	12.7%	1.976	0.5282	538.75	-6.8%
1976	15.5%	2.694	0.5325	661.53	22.8%
1977	15.7%	2.673	0.5341	724.89	9.6%
1978	15.4%	2.782	0.5261	808.16	11.5%
1979	15.6%	2.400	0.5172	899.67	11.3%
1980	14.0%	2.207	0.5205	840.90	-6.5%
1981	15.7%	1.864	0.5227	912.09	8.5%
1982	22.2%	2.221	0.5232	1,217.21	33.5%
1983	19.4%	2.353	0.5309	1,067.98	-12.3%
1984	22.3%	2.243	0.5286	1,258.76	17.9%
1985	38.2%	2.396	0.5262	1,735.77	37.9%
1986	34.3%	1.052	0.5006	1,648.61	-5.0%
1987	30.0%	2.204	0.5260	1,786.47	8.4%
1988	19.1%	1.493	0.5112	1,188.71	-33.5%
1989	25.7%	2.734	0.5178	1,314.81	10.6%
1990	22.0%	2.757	0.5275	1,145.33	-12.9%

	IBM%DOD	IBMDPZ	IBMZAV	IBMPC82	IBMDELPC
1975	2.5%	7.471	0.5348	665.59	28.2%
1976	1.6%	7.356	0.5377	438.92	-34.1%
1977	3.0%	6.746	0.5370	868.48	97.9%
1978	1.9%	5.808	0.5313	588.19	-32.3%
1979	2.4%	4.476	0.5323	755.90	28.5%
1980	1.9%	4.443	0.5207	608.27	-19.5%
1981	2.8%	4.342	0.5183	875.49	43.9%
1982	3.5%	4.728	0.5244	1,196.83	36.7%
1983	3.5%	4.977	0.5296	1,362.67	13.9%
1984	3.4%	4.151	0.5236	1,460.64	7.2%
1985	3.6%	3.215	0.5254	1,622.18	11.1%
1986	2.7%	2.701	0.5295	1,213.59	-25.2%
1987	3.3%	2.050	0.5291	1,620.66	33.5%
1988	1.8%	2.277	0.5251	926.60	-42.8%
1989	2.1%	2.011	0.5224	1,106.26	19.4%
1990	1.9%	2.100	0.5188	1,060.87	-4.1%

	LIT%DOD	LITDPZ	LITZAV	LITPC82	LITDELPC
1975	30.4%	1.045	0.5087	1,918.76	0.7%
1976	29.2%	1.092	0.5056	1,677.92	-12.6%
1977	17.7%	1.472	0.5132	967.12	-42.4%
1978	42.6%	0.754	0.5145	2,310.29	138.9%
1979	20.4%	2.862	0.5479	1,138.70	-50.7%
1980	15.4%	3.268	0.5490	798.51	-29.9%
1981	28.0%	3.725	0.5498	1,507.00	88.7%
1982	26.6%	3.369	0.5470	1,316.60	-12.6%
1983	46.0%	3.135	0.5474	2,079.51	57.9%
1984	53.0%	3.502	0.5482	2,268.35	9.1%
1985	33.3%	1.167	0.5635	1,390.79	-38.7%
1986	36.8%	0.884	0.5631	1,485.07	6.8%
1987	46.1%	0.579	0.5563	1,810.85	21.9%
1988	52.7%	0.467	0.5536	2,229.17	23.1%
1989	28.6%	0.444	0.5511	1,214.38	-45.5%
1990	30.6%	0.559	0.5536	1,300.49	7.1%

	LOC%DOD	LOCDPZ	LOCZAV	LOCPC82	LOCDELPC
1975	61.4%	0.071	0.5350	3,845.29	27.6%
1976	47.1%	1.081	0.5484	2,589.79	-32.7%
1977	50.0%	1.733	0.5503	2,656.23	2.6%
1978	63.9%	1.209	0.5208	3,303.31	24.4%
1979	44.3%	0.368	0.5214	2,457.79	-25.6%
1980	37.8%	0.349	0.5121	2,493.32	1.4%
1981	51.3%	1.024	0.5224	2,890.72	15.9%
1982	62.3%	1.617	0.5036	3,498.55	21.0%
1983	61.7%	3.110	0.4995	3,840.57	9.8%
1984	61.2%	4.936	0.4836	4,616.62	20.2%
1985	53.3%	5.374	0.4756	4,624.63	0.2%
1986	47.7%	2.760	0.4956	4,371.71	-5.5%
1987	50.3%	3.351	0.4815	4,958.67	13.4%
1988	33.9%	3.798	0.5121	3,078.90	-37.9%
1989	36.9%	1.446	0.4919	3,086.68	0.3%
1990	35.7%	2.064	0.5243	2,931.21	-5.0%

	LTV%DOD	LTVDPZ	LTVZAV	LTVPC82	LTVDELPC
1975	8.5%	0.314	0.5203	676.91	22.7%
1976	7.0%	-0.062	0.5273	541.75	-20.0%
1977	6.3%	0.581	0.5149	469.67	-13.3%
1978	7.3%	-1.192	0.5237	570.38	21.4%
1979	5.6%	0.418	0.5157	612.26	7.3%
1980	6.4%	0.419	0.5112	625.34	2.1%
1981	7.3%	0.819	0.5165	596.73	-4.6%
1982	11.5%	-1.236	0.5297	548.06	-8.2%
1983	29.3%	-1.254	0.4980	1,287.51	134.9%
1984	23.5%	-1.729	0.4929	1,538.35	19.5%
1985	19.3%	-1.698	0.4751	1,442.22	-6.2%
1986	19.9%	-8.113	0.5230	1,289.81	-10.6%
1987	17.2%	-4.858	0.5213	1,163.41	-9.8%
1988	12.9%	-9.537	0.5348	819.49	-29.6%
1989	11.9%	-8.120	0.5317	639.93	-21.9%
1990	19.3%	-8.359	0.5305	976.03	52.5%

	MAM%DOD	MAMDPZ	MAMZAV	MAMPC82	MAMDELPC
1975	30.4%	0.507	0.5128	592.00	17.1%
1976	20.5%	1.272	0.5266	426.53	-28.0%
1977	29.6%	2.090	0.5313	676.80	58.7%
1978	30.7%	3.116	0.5319	799.97	18.2%
1979	25.1%	3.408	0.5305	706.71	-11.7%
1980	30.9%	2.350	0.5162	989.82	40.1%
1981	39.1%	1.018	0.5112	1,400.43	41.5%
1982	57.0%	-1.473	0.5015	2,008.35	43.4%
1983	58.3%	0.380	0.4940	2,178.27	8.5%
1984	57.7%	-0.024	0.4987	2,101.06	-3.5%
1985	61.6%	2.886	0.5277	2,472.60	17.7%
1986	61.8%	2.856	0.5320	2,620.89	6.0%
1987	72.0%	2.302	0.5265	3,315.38	26.5%
1988	64.9%	2.503	0.5088	3,233.34	-2.5%
1989	57.6%	2.182	0.5045	2,820.42	-12.8%
1990	57.0%	2.923	0.5074	2,881.18	2.2%

	MCD%DOD	MCDDPZ	MCDZAV	MCDPC82	MCDDELPC
1975	42.9%	-1.282	0.4926	2,583.99	-4.1%
1976	69.5%	-0.198	0.4987	4,227.38	63.6%
1977	72.6%	0.878	0.5235	4,085.79	-3.3%
1978	69.3%	1.270	0.5254	4,248.21	4.0%
1979	61.2%	1.259	0.5142	4,417.49	4.0%
1980	53.5%	0.399	0.4529	3,973.75	-10.0%
1981	59.7%	0.985	0.4555	4,798.12	20.7%
1982	76.8%	1.370	0.5038	5,630.10	17.3%
1983	75.7%	2.641	0.5071	5,889.47	4.6%
1984	79.5%	2.057	0.4568	7,141.48	21.3%
1985	77.2%	1.576	0.4860	8,059.27	12.9%
1986	52.0%	1.497	0.4852	5,880.63	-27.0%
1987	56.4%	1.450	0.4774	6,864.10	16.7%
1988	53.1%	0.465	0.4939	6,964.96	1.5%
1989	61.2%	-0.632	0.4942	7,546.24	8.3%
1990	52.2%	-1.215	0.5036	7,004.27	-7.2%

	NOR%DOD	NORDPZ	NORZAV	NORPC82	NORDELPC
1975	62.8%	3.210	0.5251	1,146.62	13.5%
1976	117.0%	4.312	0.5398	2,538.91	121.4%
1977	65.4%	5.103	0.5496	1,661.38	-34.6%
1978	32.0%	4.574	0.5440	869.51	-47.7%
1979	50.6%	2.713	0.5312	1,094.77	25.9%
1980	74.1%	2.516	0.5393	1,502.25	37.2%
1981	31.3%	2.966	0.5312	677.93	-54.9%
1982	64.6%	3.352	0.5250	1,598.19	135.7%
1983	26.0%	4.174	0.5080	811.76	-49.2%
1984	23.9%	3.996	0.4531	819.78	1.0%
1985	23.6%	5.070	0.4595	1,087.25	32.6%
1986	13.2%	4.231	0.4529	662.52	-39.1%
1987	17.6%	4.148	0.4507	950.38	43.4%
1988	9.2%	3.078	0.4543	463.57	-51.2%
1989	12.0%	2.184	0.4566	533.46	15.1%
1990	13.6%	2.463	0.5235	615.87	15.4%

	RAY%DOD	RAYDPZ	RAYZAV	RAYPC82	RAYDELPC
1975	30.3%	3.258	0.5271	1,257.98	-17.3%
1976	31.9%	3.977	0.5456	1,345.53	7.0%
1977	36.9%	3.920	0.5446	1,652.27	22.8%
1978	40.3%	4.444	0.5433	1,938.85	17.3%
1979	33.5%	4.268	0.5356	1,709.13	-11.8%
1980	34.9%	3.797	0.5248	2,135.99	25.0%
1981	32.4%	3.900	0.5238	1,986.88	-7.0%
1982	41.0%	4.244	0.5261	2,262.29	13.9%
1983	46.0%	4.216	0.5273	2,615.85	15.6%
1984	51.6%	4.220	0.5225	2,874.57	9.9%
1985	46.8%	4.744	0.5079	2,728.53	-5.1%
1986	55.4%	4.863	0.4998	3,617.48	32.6%
1987	49.9%	3.453	0.4814	3,398.56	-6.1%
1988	49.5%	2.943	0.4805	3,529.46	3.9%
1989	42.8%	2.581	0.4821	3,178.94	-9.9%
1990	43.9%	2.281	0.4867	3,358.87	5.7%

	ROC%DOD	ROCDPZ	ROCZAV	ROCPC82	ROCDELPC
1975	15.2%	1.079	0.5168	1,353.62	-19.7%
1976	18.6%	2.093	0.5148	1,656.87	22.4%
1977	25.3%	2.876	0.5368	2,348.89	41.8%
1978	15.7%	2.817	0.5336	1,320.78	-43.8%
1979	11.1%	2.857	0.5362	935.56	-29.2%
1980	14.0%	3.123	0.5359	1,186.33	26.8%
1981	16.0%	3.483	0.5380	1,225.21	3.3%
1982	36.4%	3.830	0.5350	2,690.52	119.6%
1983	56.1%	4.369	0.5367	4,357.73	62.0%
1984	66.7%	4.527	0.5375	5,780.06	32.6%
1985	55.3%	3.484	0.5211	5,699.77	-1.4%
1986	45.5%	3.720	0.5294	4,990.79	-12.4%
1987	18.5%	3.167	0.5355	1,990.97	-60.1%
1988	18.3%	2.884	0.5304	1,900.67	-4.5%
1989	17.0%	3.002	0.5108	1,802.88	-5.1%
1990	17.9%	2.635	0.5144	1,829.45	1.5%

	TEX%DOD	TEXDPZ	TEXZAV	TEXPC82	TEXDELPC
1975	22.2%	0.972	0.4876	1,009.06	17.4%
1976	14.1%	1.659	0.5168	637.63	-36.8%
1977	16.2%	1.658	0.5281	721.74	13.2%
1978	26.9%	1.993	0.5224	1,287.12	78.3%
1979	14.0%	1.752	0.4877	652.01	-49.3%
1980	17.1%	0.742	0.4819	708.37	8.6%
1981	14.4%	0.964	0.4779	521.20	-26.4%
1982	19.9%	0.719	0.5069	583.69	12.0%
1983	22.5%	1.067	0.5181	643.51	10.2%
1984	25.0%	1.217	0.4933	748.21	16.3%
1985	47.5%	-1.122	0.4926	1,746.60	133.4%
1986	41.1%	-1.216	0.4936	1,721.88	-1.4%
1987	32.2%	-0.119	0.4621	1,542.69	-10.4%
1988	27.8%	0.086	0.4623	1,296.20	-16.0%
1989	22.4%	-0.126	0.4442	1,001.30	-22.8%
1990	21.7%	0.086	0.4808	982.16	-1.9%

	UT%DOD	UTDPZ	UTZAV	UTPC82	UTDELPC
1975	36.3%	0.470	0.5256	2,601.57	4.3%
1976	23.9%	2.028	0.5315	2,115.12	-18.7%
1977	28.5%	2.866	0.5361	2,515.37	18.9%
1978	38.3%	1.222	0.5218	3,560.52	41.6%
1979	28.2%	-0.018	0.5060	3,493.23	-1.9%
1980	25.2%	0.702	0.5009	3,805.26	8.9%
1981	27.6%	1.196	0.5014	4,108.37	8.0%
1982	31.0%	1.213	0.4943	4,208.29	2.4%
1983	26.4%	1.521	0.5044	3,708.00	-11.9%
1984	19.6%	1.410	0.5023	2,980.30	-19.6%
1985	26.1%	1.481	0.5276	3,553.80	19.2%
1986	22.5%	0.999	0.5073	3,149.12	-11.4%
1987	20.9%	0.598	0.5130	3,191.30	1.3%
1988	19.5%	0.927	0.4997	3,053.14	-4.3%
1989	18.2%	1.523	0.5019	3,006.16	-1.5%
1990	13.3%	1.345	0.4955	2,356.24	-21.6%

	WES%DOD	WESDPZ	WESZAV	WESPC82	WESDELPC
1975	5.4%	1.661	0.5244	581.36	-38.6%
1976	7.9%	1.869	0.5293	827.45	42.3%
1977	13.1%	1.928	0.5294	1,273.22	53.9%
1978	8.1%	2.022	0.5351	799.98	-37.2%
1979	9.0%	1.204	0.5382	902.53	12.8%
1980	10.9%	2.202	0.5335	1,140.82	26.4%
1981	12.0%	1.772	0.5279	1,223.88	7.3%
1982	15.3%	2.163	0.5215	1,491.70	21.9%
1983	18.7%	2.316	0.5205	1,705.02	14.3%
1984	18.9%	2.524	0.5217	1,806.25	5.9%
1985	18.1%	2.377	0.5253	1,766.40	-2.2%
1986	16.0%	2.336	0.5240	1,529.63	-13.4%
1987	15.8%	2.265	0.5372	1,498.33	-2.0%
1988	18.8%	2.401	0.5305	1,901.62	26.9%
1989	14.2%	2.027	0.5311	1,394.43	-26.7%
1990	19.4%	0.706	0.5284	1,850.98	32.7%

	GNP 82$	DELTA GNP	NATIONAL OUTLAYS 82$
1975	2695.0	-1.3	586.0
1976	2825.6	4.9	609.8
1977	2958.4	4.7	622.6
1978	3115.2	5.3	652.2
1979	3192.4	2.5	660.1
1980	3187.1	-0.2	699.1
1981	3248.8	1.9	726.5
1982	3166.0	-2.5	745.7
1983	3279.1	3.6	775.0
1984	3501.4	6.8	788.1
1985	3618.7	3.4	849.7
1986	3717.9	2.7	868.0
1987	3845.3	3.4	858.5
1988	4016.9	4.5	880.8
1989	4117.7	2.5	909.6
1990	4157.3	1.0	955.5

	PRIME CONTRACTS 82$	DELTA PRIME CONTRACTS	DOD OUTLAYS 82$
1975	73.0	3.2	159.9
1976	72.0	-1.3	153.6
1977	80.0	11.0	154.4
1978	88.4	10.5	155.0
1979	86.5	-2.2	159.2
1980	94.0	8.7	164.0
1981	106.0	12.7	171.4
1982	116.7	10.1	185.3
1983	122.9	5.3	201.2
1984	124.2	1.0	211.4
1985	137.1	10.4	230.0
1986	130.1	-5.1	244.1
1987	126.8	-2.5	250.9
1988	119.2	-6.0	252.7
1989	109.0	-8.5	256.6
1990	107.9	-1.0	247.0

	PRO+RDT&E 82$	DELTA PRO+RDT&E	CAPACITY UTILIZATION
1975	46.0	-6.2	*
1976	42.7	-7.3	76.2%
1977	44.4	0.6	78.7%
1978	45.2	1.9	83.6%
1979	50.0	10.6	85.4%
1980	51.6	3.2	75.6%
1981	54.9	6.5	77.1%
1982	61.0	11.1	63.9%
1983	71.1	16.6	70.8%
1984	79.0	11.0	81.1%
1985	88.7	12.3	77.2%
1986	97.1	9.5	74.5%
1987	101.8	4.8	76.5%
1988	97.5	-4.2	81.0%
1989	100.3	2.9	81.3%
1990	97.7	-2.5	81.1%

LIST OF REFERENCES

Altman, Edward I., *Corporate Financial Distress*, John Wiley & Sons, 1983.

Altman, Edward I., "Financial Ratios, Discriminant Analysis and the Prediction of Corporate Bankruptcy," *Journal of Finance*, v. 23, pp. 589-609, September 1968.

Brigham, Eugene F., and Gapenski, Louis C., *Financial Management Theory and Practice*, 6th ed., The Dryden Press, 1991.

Board of Governors of the Federal Reserve System, *Federal Reserve Bulletin*, (various monthly issues).

Bush, George, Remarks by the President to the Aspen Institute Symposium, 2 August 1990.

Chen, Kung H. and Shimerda, Thomas A., "An Empirical Analysis of Useful Financial Ratios," *Financial Management*, v. 10, pp. 51-60, Spring 1981.

Dagel, Harold W. and Pepper, Ranae, "A Financial Distress Model for DoD Hardware Contractors," unpublished paper, Naval Center for Cost Analysis, March 1989.

Davidson, Sidney, Stickney, Clyde P., and Weil, Roman L., *Financial Accounting An Introduction to Concepts, Methods, and Uses*, 4th ed., The Dryden Press, 1988.

Enthoven, Alain C. and Smith, K. Wayne, *How Much Is Enough? Shaping the Defense Program 1961-1969*, Harper & Row, 1971.

Fox, J. Ronald, *The Defense Management Challenge*, Harvard Business School Press, 1988.

Gansler, Jacques S., *The Defense Industry*, The MIT Press, 1980.

Government Accounting Office, *Assessment of the Study of Defense Contractor Profitability*, GAO/NSIAD-87-50, December 1986.

Greer, Willis R., and Liao, Shu S., "An Analysis of Risk and Return in the Defense Market: Its Impact on Weapon System Competition," *Management Science*, v. 32, pp. 1259-1273, October 1986.

Hawkins, David F., *Corporate Financial Reporting and Analysis*, 3rd ed., Irwin, 1986.

Hearings before the Committee on Armed Services, United States Senate, S. 2884, 1990.

James, Craig E., *Department of Defense Expenditure Impact on State Economic Growth*, Master's Thesis, Naval Postgraduate School, Monterey, California, December 1988.

Lewis, Kevin N., *National Security Spending and Budget Trends Since World War II*, The RAND Corporation, N-2872-AF, June 1990.

Moody's Investors Services, Inc., *Moody's Industrial Manual*, (various issues).

Moody's Investors Services, Inc., *Moody's Public Utilities Manual*, (various issues).

Morse, John Prescott, and Kramer, Kenyon Paul, *DoD Contractor Profitability 1980-1984*, Master's Thesis, Naval Postgraduate School, Monterey, California, December 1985.

Newbold, Paul, *Statistics for Business and Economics*, 2d ed., Prentice Hall, 1988.

Nicholson, Walter, *Microeconomic Theory Basic Principles and Extensions*, 4th ed., The Dryden Press, 1989.

Pinches, George E., Eubank, Arthur A., Mingo, Kent A., and Caruthers, J. Kent, "The Hierarchical Classification of Financial Ratios," *Journal of Business Research*, v. 3, pp. 295-310, October 1975.

Pinches, George E., Mingo, Kent A., and Caruthers, J. Kent, "The Stability of Financial Patterns in Industrial Organizations," *The Journal of Finance*, v. 28, pp. 389-396, May 1973.

Robert Morris Associates, *Annual Statement Studies*, 1991.

RRG Associates, *Financial Analysis of Major Defense Contractors 1977-1989*, 1 July 1990.

Standard & Poor's Investors Services, Inc., *Standard & Poor's Corporate Record*, 1991.

Standard & Poor's COMPUSTAT Services, Inc., *Industrial COMPUSTAT Manual*, 1987.

The White House, *The National Security Strategy of the United States*, 1991.

Treglia, Michael, *Financial Analysis of the Major Defense Contractors*, Research Memorandum, Center for Naval Analysis, CRM 91-103, May 1991.

United States Bureau of the Census, *Quarterly Financial Report for Manufacturing, Mining, and Trade Corporations*, First Quarter, 1991, Series QFR-91-1, U.S. Government Printing Office, Washington, D.C., 1991.

United States Department of Commerce, *Survey of Current Business*, Economics and Statistics Administration/Bureau of Economic Analysis, (various issues).

United States Department of Defense, *Defense Financial and Investment Review*, (DFAIR), June 1985.

United States Department of Defense, Directorate for Information, Operations, and Reports (DIOR), *100 Companies Receiving the Largest Dollar Volume of Prime Contract Awards*, Government Printing Office, Washington, D.C., (published annually for each fiscal year).

United States Government Printing Office, *Economic Indicators*, Washington, D.C., (various issues).

United States Office of Management and Budget, *Budget of the United States Government, Fiscal Year 1992, Historical Tables*, Washington, D.C., 1991.

Zavgren, Christine V., "Assessing the Vulnerability to Failure of American Industrial Firms: A Logistic Analysis," *Journal of Business Finance & Accounting*, v. 12, Spring 1985.

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